Report No. 16

# SIXTH ANNUAL REPORT

OF THE

# SCIENTIFIC AND INDUSTRIAL RESEARCH COUNCIL OF ALBERTA

# 1925

PRINTED BY ORDER OF THE LEGISLATIVE ASSEMBLY

EDMONTON:
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The Scientific and Industrial Research Council of Alberta, formed in January, 1921, carries on its work in co-operation with the University of Alberta.

The personnel of the Council at the present time is as follows:

Hon. Alex. Ross, Minister of Public Works, Chairman.
H. M. Tory, President, University of Alberta.
J. T. Stirling, Chief Inspector of Mines, Province of Alberta.
J. A. Allan, Geologist.
N. C. Pitcher, Mining Engineer.
R. W. Boyle, Dean, Faculty of Applied Science, University of Alberta.
Edgar Stansfield, Honorary Secretary, Industrial Research Department, University of Alberta.

Requests for information and reports should be addressed to the Secretary, Industrial Research Department, University of Alberta, Edmonton, Alberta.

# TABLE OF CONTENTS

University of Alberta,
Edmonton, Alberta,
February 20th, 1926.

Hon. Alex Ross,
*Minister of Public Works*,
Edmonton, Alberta.

Sir:—

Under instruction from the Scientific and Industrial Research Council of Alberta, I herewith submit their Sixth Annual Report. This covers the work done under their direction during the year ending December 31st, 1925.

Respectfully submitted,

Edgar Stansfield,
*Honorary Secretary*.

# SIXTH ANNUAL REPORT OF THE SCIENTIFIC AND INDUSTRIAL RESEARCH COUNCIL OF ALBERTA

## ORGANIZATION

In the organization of the University of Alberta the staff of the Research Council constitutes the Industrial Research Department, and the Research Council's laboratories are referred to as the Industrial Research laboratories.

In the organization of the Provincial Government the work of the Research Council is attached to the Executive Council.

## PERSONNEL AND MEETINGS OF COUNCIL

Three meetings of the Council were held during the year. In November the Hon. Herbert Greenfield resigned from the Chairmanship, and his place was taken by the Hon. Alex. Ross, Minister of Public Works. The personnel of the Council on December 31st was:

Hon. Alex Ross, Minister of Public Works, Chairman.

H. M. Tory, President, University of Alberta.

J. T. Stirling, Chief Inspector of Mines, Province of Alberta.

J. A. Allan, Geologist, University of Alberta.

N. C. Pitcher, Mining Engineer, University of Alberta.

R. W. Boyle, Dean, Faculty of Applied Science, University of Alberta.

Edgar Stansfield, Honorary Secretary.

## STAFF

The following changes in the permanent staff have been made during the year:

J. C. Brennan commenced work as Office Assistant on June 8th.

Marjorie D. Walker resigned her position as Geological Stenographer on September 25th.

J. B. Coghill resigned his position as Recording Secretary on October 1st.

Hazel M. Wortman commenced work as Bookkeeper-Stenographer on September 14th, in place of J. B. Coghill resigned.

Margaret C. Owens commenced work as Geological Stenographer in place of Marjorie D. Walker on October 1st.

The permanent staff on December 31st, 1925, was as follows:
EDGAR STANSFIELD, Research Engineer, *Fuels;*
K. A. CLARK, Research Engineer, *Road Materials;*
R. T. HOLLIES, Assistant Research Engineer, *Fuels;*
R. L. RUTHERFORD, Geologist, *Geology;*
S. M. BLAIR, Assistant Research Engineer, *Road Materials;*
W. P. CAMPBELL, Fuel Analyst, *Fuels;*
W. A. LANG, Assistant Engineer, *Fuels;*
HAZEL M. WORTMAN, Accountant and Stenographer;
MARGARET C. OWENS, Geological Stenographer;
J. D. BAIRD, Laboratory Assistant;
J. C. BRENNAN, Office Assistant.

In addition to the above, Professors J. A. Allan and N. C. Pitcher, of the University of Alberta, members of the Council, are in permanent charge of the Council's research work in Geology and Mining Engineering, respectively. Associate Professor A. E. Cameron acts as secretary to the Council and has charge of the office staff.

Other members of the University staff have assisted from time to time; notably Prof. R. S. L. Wilson, who devoted considerable time throughout the year to work for the Council on the forest products of Alberta, with special reference to mine timber.

A number of other persons held summer or short term appointments under the Council:

In the Geology Division: L. S. Russell, field assistant on survey party; C. M. Mealing, instrument man; Agnes M. Owens, stenographer; G. C. Haworth and Charles Mackenzie, packer and cook on the survey party; F. M. Etheridge, G. J. Knighton and L. S. Russell, draftsmen.

In the Road Materials Division: J. V. Lehmann, Chemist; M. Ray and C. J. Ferguson, Laboratory Assistants.

In the Forest Products Division; R. K. Muir and A. K. Cox rendered occasional service.

## LABORATORIES AND EQUIPMENT

The most notable change during the year was in connection with the bituminous sand separation plant erected at the Dunvegan Yards of the E. D. and B. C. railway in Edmonton. This plant was completely remodelled, with the addition of elevating, crushing and mixing machinery.

The laboratory accommodation at the University for the work of the Council was increased by the addition of a small laboratory for testing gravels and other road materials. A small room was also made available for briquetting work at the end of the year, but not equipped.

The principal items of new laboratory equipment acquired during the year are as follows: A.S.T.M. Air Drying Apparatus, Uehling $CO_2$ Machine, 2 each illium and platinum crucibles,

Kjeldahl electrically heated distilling apparatus, Kjeldahl digestion shelves, 2 Leeds and Northrup duplex recording pyrometers, Dennstedt apparatus, filter press and tenacity apparatus. Additions were also made to the library.

## FUELS.

The work of previous years was continued, and some fresh work begun, under the direction of Mr. E. Stansfield. No carload samples were tested, as no time could be spared for this work. Three special samples were received for briquetting tests and one for smithy tests.

Storage and screening tests were continued. No boiler trials were made.

Good progress was made with the work on domestic heaters, both in the laboratories and in a residence. In the laboratories the method devised for hot air furnace testing was improved and its reasonable accuracy established. It is proposed to publish during the coming year a comprehensive report on the work of the past five years on domestic heaters.*

Marked progress was also made during the year with briquetting. It is also proposed to publish an account during the year on the briquetting investigation of the past three years, so that only a brief statement of the principal results of 1925 are here included.* Two hundred and eleven batches of briquettes were made, 28 with semi-anthracite coal from the Cascade area, 3 with bituminous coal from the Crowsnest area and 180 with sub-bituminous coal from the Coalspur area. The principal binder employed during the year was asphalt, but coal tar pitch and mixed binders were also used. Asphalts from different sources were tested, and it was shown that asphalts prepared from the bitumen of the McMurray district and from Wainwright oil gave excellent results.

A commercial briquetting plant was built during the year by the Canmore Coal Company at Canmore. The work of the laboratory in the latter part of the year was planned to obtain information useful to this plant.

A notable portion of the year's work on briquetting was concerned with a careful study of the effect of the size of coal particles on the quality of the briquettes.

Work carried on for the Provincial Mines Branch included the analysis of 160 samples of coal and 28 samples of coal dust taken by the Provincial Inspectors of Mines. The analyses made during the past three years for the Mines Branch were compiled and published during the year.

Papers on subjects relating to the fuels of the province were given at general meetings of the Canadian Institute of Mining and Metallurgy and of the Engineering Institute of Canada. In addi-

*No funds will be available for these publications before 1927.

tion, information was given verbally and in written memoranda to the Alberta Coal Commission.

A more detailed report of several branches of the work on fuels is given as an appendix.

## GEOLOGY

The work of the Geological Survey Division of the Council is carried on in conjunction with the Department of Geology at the University of Alberta, under the direction of Dr. J. A. Allan. The palaeontological material obtained on field surveys is determined by Dr. P. S. Warren, and in return for this co-operation Dr. R. L. Rutherford assists in teaching in the Department of Geology.

The correspondence in connection with the mineral resources so increased that stenographic assistance was required for the whole year. The drafting also increased, necessitating extra assistance from certain students of the University.

Two reports and four geological maps were published by the Council. Two additional reports were prepared by Dr. Allan and published elsewhere.

The new geological map of Alberta, which has been in preparation for the past two years, is published on a scale of one inch to 25 miles and appears in 14 colors.

One geological party under Dr. Rutherford spent four months in the field continuing the foothills survey started in 1922.

Dr. Allan did field work in the Blackstone gap and Bighorn basin, and also on North Saskatchewan river. In addition, other localities in the province were visited in connection with the study of the mineral resources.

An appendix to this report gives the scope of the work carried on by the Geological Survey Division during the year 1925.

Compilation of data for the Alberta Coal Commission required considerable time, and Dr. Allan has included in his report the results of this study on available coal supply in Alberta.

## ROAD MATERIALS

The study of Dr. Clark's process for separating bitumen from bituminous sands, and also of the use of the bitumen so separated for the improvement of earth roads, was continued during the year. The use of Wainwright crude oil for earth road was also studied, under the direction of Dr. K. A. Clark.

The semi-commercial bituminous sand separation plant was operated. One mile of bituminized earth road surface was constructed, making use of both the bitumen from the separation plant and of Wainwright crude oil.

A laboratory bituminous sand separation apparatus was assembled. A large number of tests were made with this apparatus during the winter months, and much important information was secured about features of the separation process which had given trouble in the large scale operations.

Early in the spring work was resumed at the separation plant which had been built in 1924 at the Dunvegan Yards, Edmonton. Modifications were made in the plant to obviate difficulties encountered in 1924 and based on the new information obtained in the laboratory during the winter. The plant was put into operation to treat 500 tons of bituminous sand. This work proceeded smoothly and the programme was successfully completed before the end of July. Excellent results were secured.

The construction of experimental road surface was commenced about the middle of June, and was completed by the middle of August. Bitumen from the separation plant was used on 3,500 feet of roadway and Wainwright crude oil on 2,000 feet. The portion of the road treated with bitumen resisted the effect of traffic and wet weather satisfactorily from the time of completion until covered by snow and ice. The portion treated with Wainwright oil did not behave so well, but gave interesting results.

The chemical laboratory was used to control the operation of the separation plant.

## FOREST PRODUCTS

The work outlined in the 1923 report was continued during the year by Professor R. S. L. Wilson. Tests are still in progress on the suitability of lodge pole pine for mine timber under varied conditions, and additional results are being compiled. Further particulars of this work will be found in the appendix, and it is expected that publication of detailed results can be made in 1927.

## MISCELLANEOUS

In March two papers were presented to the Annual Meeting of the Canadian Institute of Mining and Metallurgy, held at Ottawa: "A Chemical Survey of Alberta Coals", by Edgar Stansfield; and "Geology of Alberta Coal", by J. A. Allan.

While in the East Mr. Stansfield also visited Montreal and the Central Heating Plant of the Hydro Electric at Winnipeg.

On April 6th Mr. Stansfield visited the oil wells at Wainwright, and on May 5th attended the Coal Commission enquiry.

In July Mr. Stansfield presented a paper to the meeting of the Engineering Institute of Canada at Banff, on "The Scientific and Industrial Research Council of Alberta".

In November Dr. Allan attended the Annual Western Meeting of the Canadian Institute of Mining and Metallurgy at Winnipeg.

Professors N. C. Pitcher and R. S. L. Wilson visited the Black Diamond Collieries of the Great West Coal Company during the course of the tests on mine timber.

On November 11th the Coal Commission visited the laboratories of the Research Council.

## ACKNOWLEDGMENTS

Appreciation is expressed to all those who have given assistance in carrying through the work of the year.

The Department of Railways continued the same helpful attitude which they displayed during the 1924 season and did much to make the work at the separation plant a success. Use of facilities at the A. & G. W. railway shops, beside which the plant was located, and the general good will of the officials in charge were of great assistance.

The co-operation of the Public Works Department made the road construction programme possible. The Minister of Public Works gave permission to carry on the experimental work on the St. Albert Trail. The Department graded up a mile of roadway and loaned road building machinery.

The McMurray Asphaltum & Oil Company, from whom the bituminous sand was purchased, and the Crown Soap Company, who provided at cost price the silicate of soda required, both displayed special interest in helping along the work.

Messrs. J. C. and A. C. Dunn, of the Great West Coal Company, Limited, continued to provide facilities for timber testing at the mine.

# FUELS DIVISION

By E. Stansfield, R. T. Hollies, W. P. Campbell and W. A. Lang.

Prof. N. C. Pitcher, Chief Mining Engineer, assisted with suggestions and advice with most of the work described.

R. T. Hollies was engaged almost entirely on furnace testing.

W. P. Campbell, Fuel Analyst, made all coal analyses reported, and carried out some laboratory investigations.

W. A. Lang was engaged on briquetting work.

## Coals Tested

No carload samples were received during the year. Three consignments of coal were obtained for briquetting. Two of these were donated by the operators, one ton from the Coal Valley Mining Company, Coalspur Area, and half a ton from the Canmore Coal Company, Cascade area. The third consignment was purchased from the Coalspur area. One sample of American smithy coal was also tested.

Provincial Inspectors of Mines submitted 160 coal and 28 coal dust samples for analyses. Of the 160 coals, 45 were Kootenay, 39 Belly River and 76 Edmonton. In the past 6 years 760 of these samples have been sent in. A special feature of the work of the year was sampling outlying districts. Up to the end of 1924 samples received had come from 72 separate townships. At the end of 1925 the number of townships had been increased to 112. In 1924 coal was being produced from approximately 156 townships, many of which were only represented by mines of small output. These figures indicate how nearly the chemical survey of the coal of the province has covered the operating areas. Five coal samples from a bore hole at Wainwright were received and 12 miscellaneous samples, in addition to the many routine samples taken in connection with the regular work of the laboratories.

## Storage and Screening

As only one sample now remains in storage and this test will be completed early in 1926, it does not appear advisable to report further on this work at present.

## Sampling and Analysis

No change in method was adopted during the year. The standard air drying apparatus, however, was improved by the installation, in February, of a small motor-driven pump to ensure a continuous and rapid circulation of the calcium chloride solution used to maintain the required humidity. This increased circulation was

found necessary to give the desired humidity during the winter when the laboratory air is extremely dry.

A further study was made of the possible loss of combustible volatile matter during the drying of high volatile coals. In the work reported last year coals were dried at room temperatures in vacuo over sulphuric acid and then heated to 105°C for one hour in a current of natural gas. After 2 weeks drying the heat loss was 0.52%, and after 3 weeks drying only 0.35%. In the new tests coal was dried by being heated to 105°C for two hours or more in a current of nitrogen, in an apparatus designed for the purpose, and so arranged that all the gases leaving the dryer passed immediately into the combustion apparatus used for the ultimate analysis of coal. In this combustion apparatus any hydrocarbons would be completely burned. The carbon dioxide and water produced were collected and weighed. The results with six tests were as follows:

Edmonton coal, carbon evolved: (1) 0.12% (2) 0.15%
Drumheller coal, carbon evolved: (1) 0.06% (2) 0.14% (3) 0.11%
Crowsnest coal, carbon evolved: (1) 0.07%

If the hydrocarbon is assumed to be methane, the above figures should be multiplied by 1.33 to convert from percentage of carbon to percentage of methane. The highest result of the six tests is thus only 0.2% methane, and this in an experiment exposed to twice the normal time of heating. Further work is to be done in this direction as time is available.

## CHEMICAL SURVEY OF ALBERTA COALS

A study of the many hundred available analyses of Alberta coals was begun in 1924, and a preliminary report of the work published. The work was continued in 1925, and a paper was presented by E. Stansfield to the Annual Meeting of the Canadian Institute of Mining and Metallurgy in March.* A possible classification of Alberta coals was here suggested for consideration.

At a conference of the Provincial Government officers principally concerned, held on the 7th of February, 1925, it was decided to recommend that the analyses of the coals of the province should be published, but only by districts. This recommendation was carried out by the Research Council, and Report No. 14, "Analyses of Alberta Coal", was accordingly prepared and published.

## DOMESTIC FURNACES

This work has been in progress for five years. A number of different furnaces and furnace appliances have been tested and the results reported. The main achievement, however, has been in the development of a calorimeter for use in measuring the heat contained in a stream of air or gas; the employment of this for

*A Chemical Survey of Alberta Coals—Trans. C.I. of M. & M., Vol. XXVIII, 1925, p. 412.

measuring the chimney heat losses for any type of furnace, and for measuring the heat in the air current from a hot air furnace. This calorimetric method has been improved from time to time, and its accuracy finally established. The method has also been employed to ascertain the variation in efficiency of a hot air furnace with variations in the rate of air circulation through the furnace casing.

In view of the above, it is proposed to prepare and publish during the coming year, a special report on the work to date, and only a brief account of the year's work, therefore, will be included in this Annual Report.*

The additions to the equipment during the year were as follows: rectograph, exhauster fan, Uehling $CO_2$ machine, additions to house calorimeter, stand for house calorimeter, anemometer, 2 duplex copper-constantan thermocouple recorders; the baffles in the house calorimeter were increased and the furnace joints carefully recemented at the end of the year.

Many circular charts have been obtained during the course of the work. These are hard to compare and are also distorted. An instrument was devised, and constructed in the University workshops, whereby a circular chart can be mechanically reproduced on rectangular co-ordinates. As many charts as desired can now be drawn on a single sheet for ready comparison. The name "rectograph" has been suggested for this instrument. Fig. 1 shows 6 circular charts and the corresponding curves as transferred to rectangular co-ordinates by the instrument.

Figures 2 and 3 show furnace testing equipment.

An exhauster fan was installed on the furnace testing apparatus, as shown in Fig. 2. Dampers were installed just below the fan to regulate the current of air through the furnace.

The furnace work of the year consisted chiefly of erection, testing and proving of this calorimetric system for the study of the performance of warm air furnaces. The heat input was supplied by the 20 k.w. electric heater used in the hot water furnace tests reported last year. Six tests were run of 8 hours duration each, and 76 tests of one hour each. In the one hour tests the furnace was heated for 4 or 5 hours, under the desired adjustment of drafts, etc., until steady conditions were obtained. Then a two or three hour test was made, although the results for each hour were calculated separately for check purposes. When a change of adjustment was made, conditions were allowed to become steady again before a further set of tests was made. With electrical heating it was possible to maintain very steady conditions over a three-hour period. Greater accuracy could be obtained with these short tests than with the longer tests where atmospheric conditions seldom remained constant.

The tests of the year can be divided into three series.

*First*: A series of tests made on the furnace using the electric heater. The results obtained are not reported here, as they were

*No funds will be available for this publication before 1927.

erratic. These results showed the need of more thorough mixing of the air before passing through the calorimeter, more sensitive methods of measuring the drop in temperature of the air passing through the calorimeter, and a greater heat absorption in the calorimeter. These preliminary runs also proved that for the short tests, with the electric heater, it was necessary to control the room temperature, flue losses and energy input within small limits.

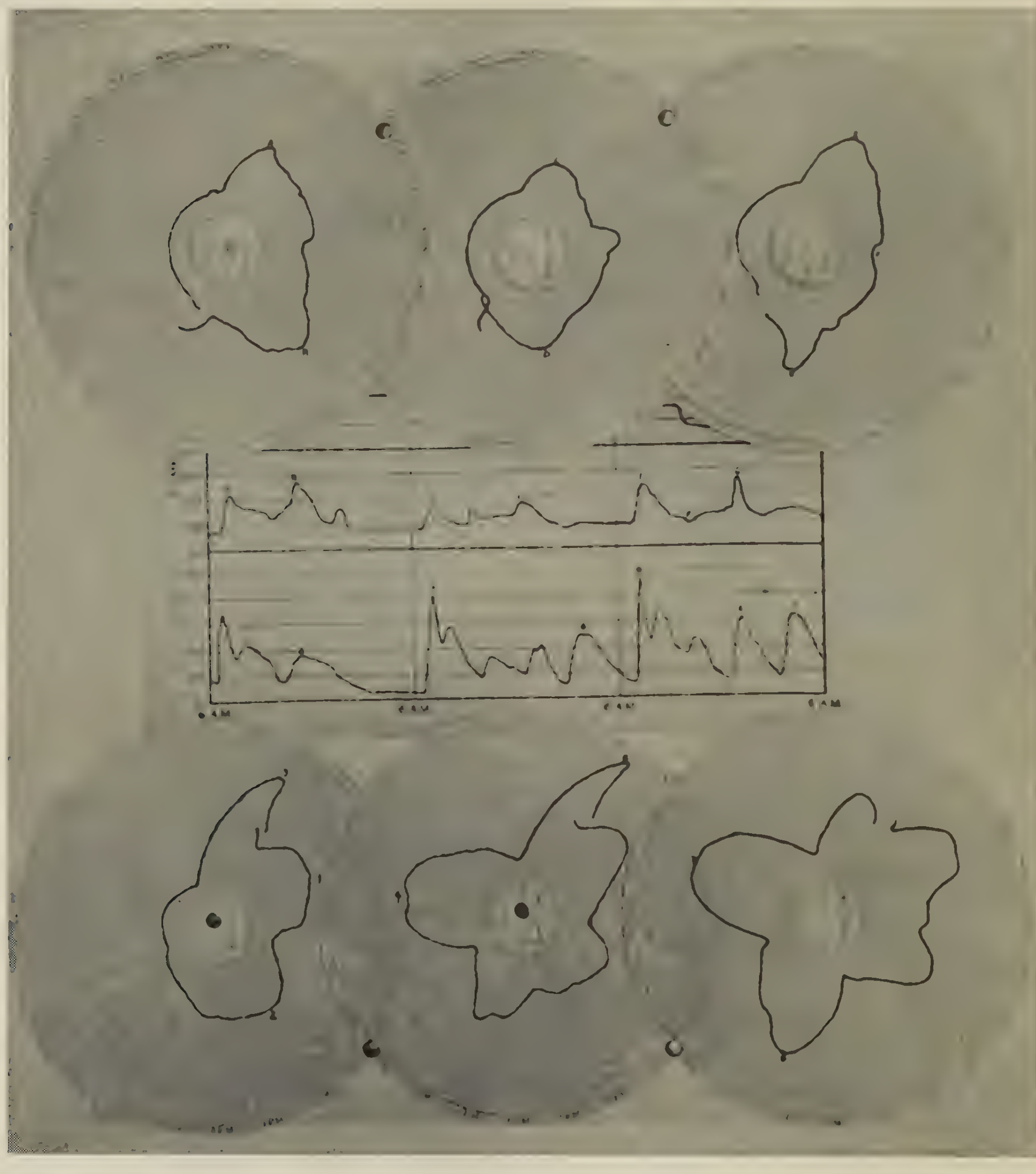

**Figure 1.**—Curves on Circular and Rectangular Coordinates.

*Second*: A series of runs was made after the apparatus had been adjusted to meet the difficulties shown up by the first series. The results obtained are indicated in Fig. 4.

*Third*: The furnace was dismantled and rebuilt, each joint being carefully cemented to prevent leakage of air from the fire box into the casing. An asbestos backed bright metal lining was installed in the casing, and the furnace erected on an asbestos mat to reduce radiation losses. The third series of tests was carried out with the furnace so reconstructed. The results of these tests are also indicated in Fig. 4.

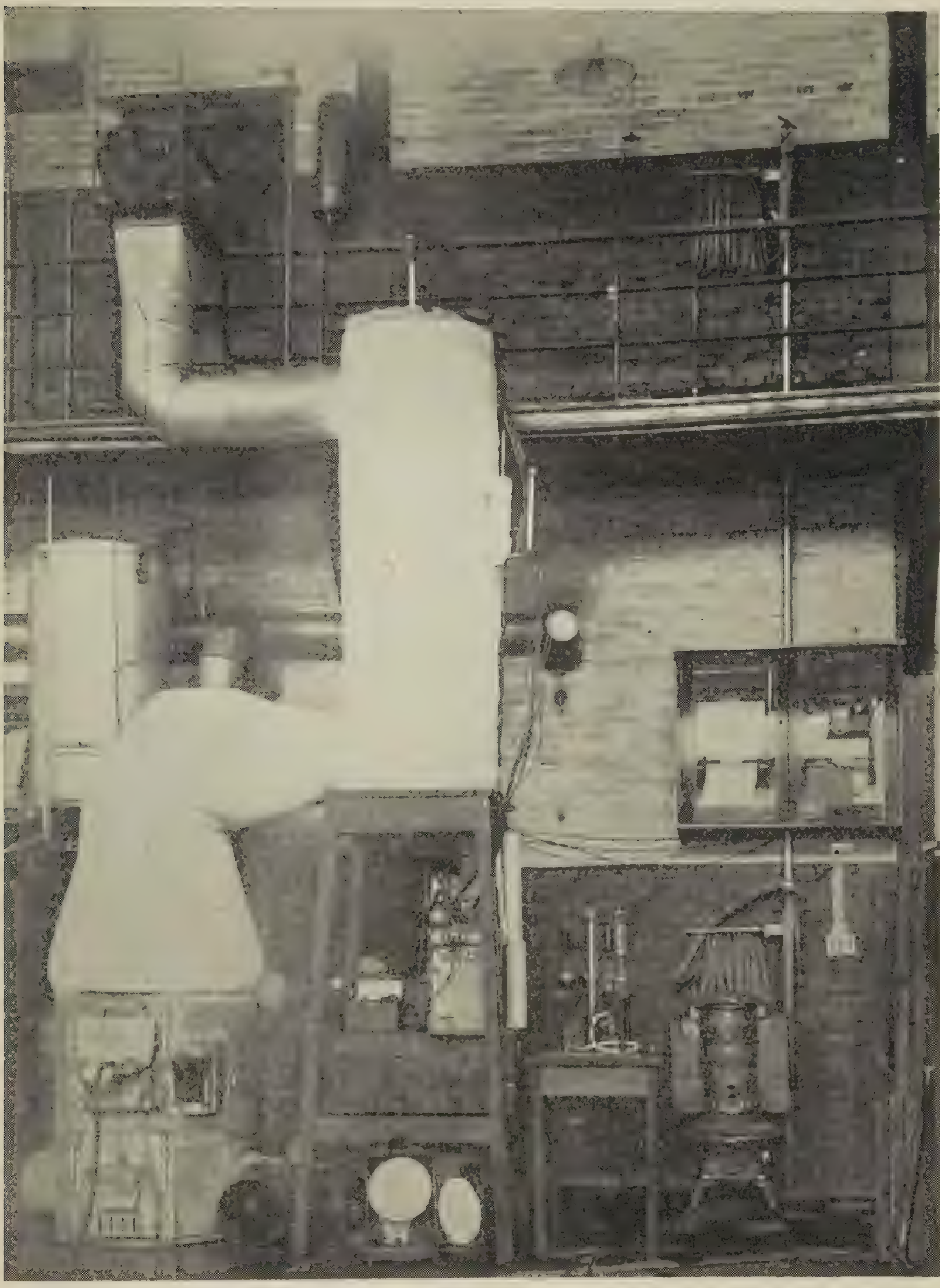

**Figure 2.**—Furnace Testing Equipment.

Some difficulties were encountered in comparing the results of the different tests, because not only was the air circulation deliberately changed, but the flue losses also were inadvertently altered. It was found, however, that if in the computations the heat lost up the chimney was deducted from both the electric energy supplied to the furnace and the distribution of heat from the furnace, the desired comparisons could be made. Thus if in any test the energy supplied was 16 k.w. hours per hour, and the furnace heat distribution was 56% in the hot air, 20% in the flue, and 24% (by difference) in radiation, then omitting the flue losses from consideration, the effective k.w.h. per hour would equal 12.8,

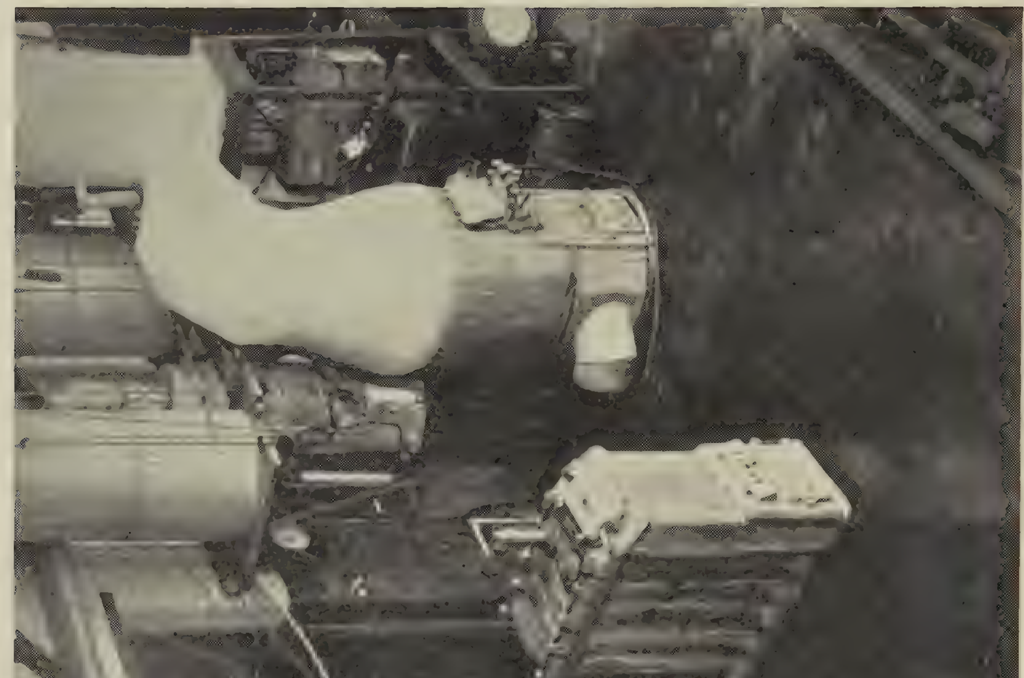

Figure 3.—Furnace Testing equipment.

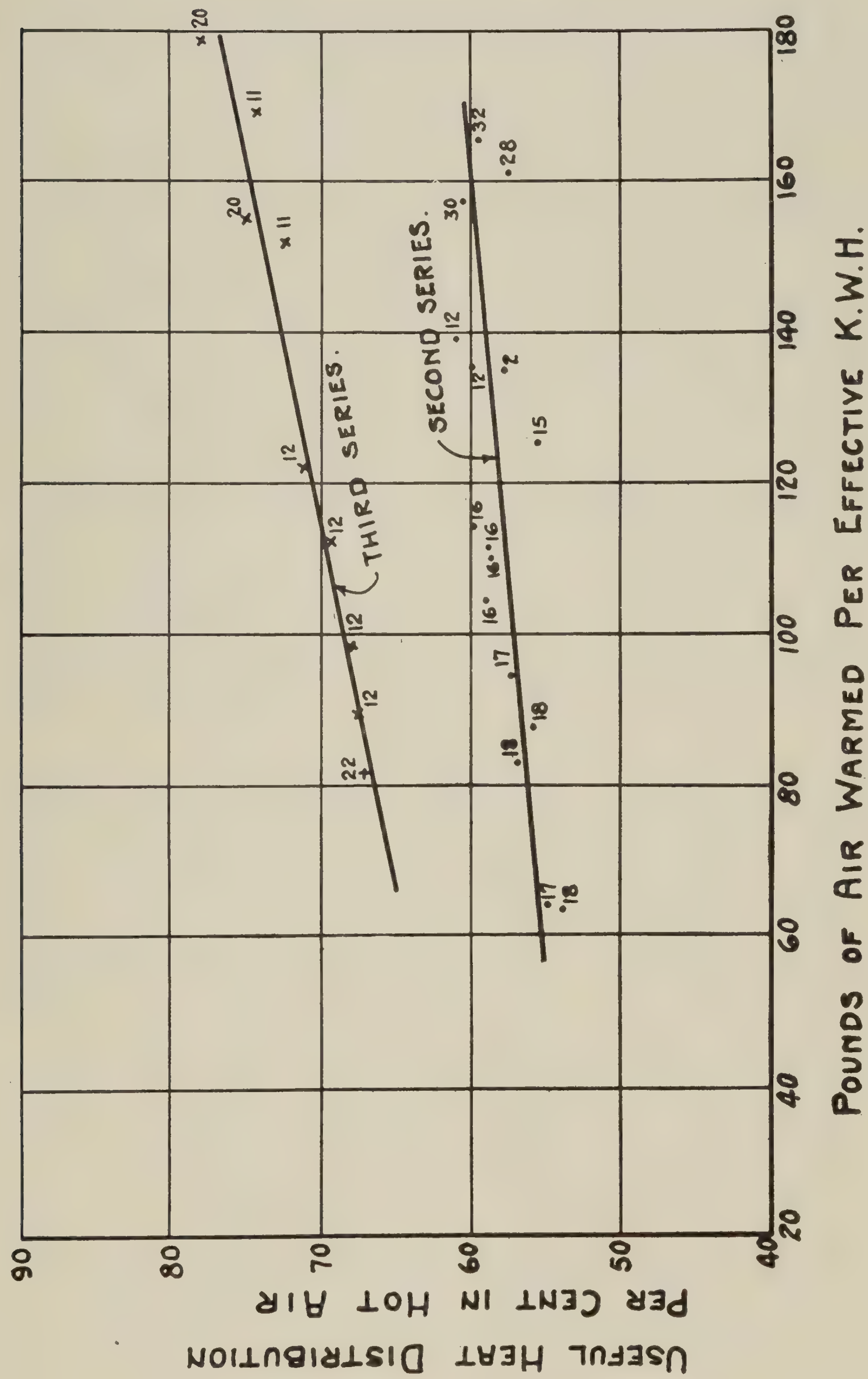


Figure 4.—Distribution of Useful Heat from Hot Air Furnace.

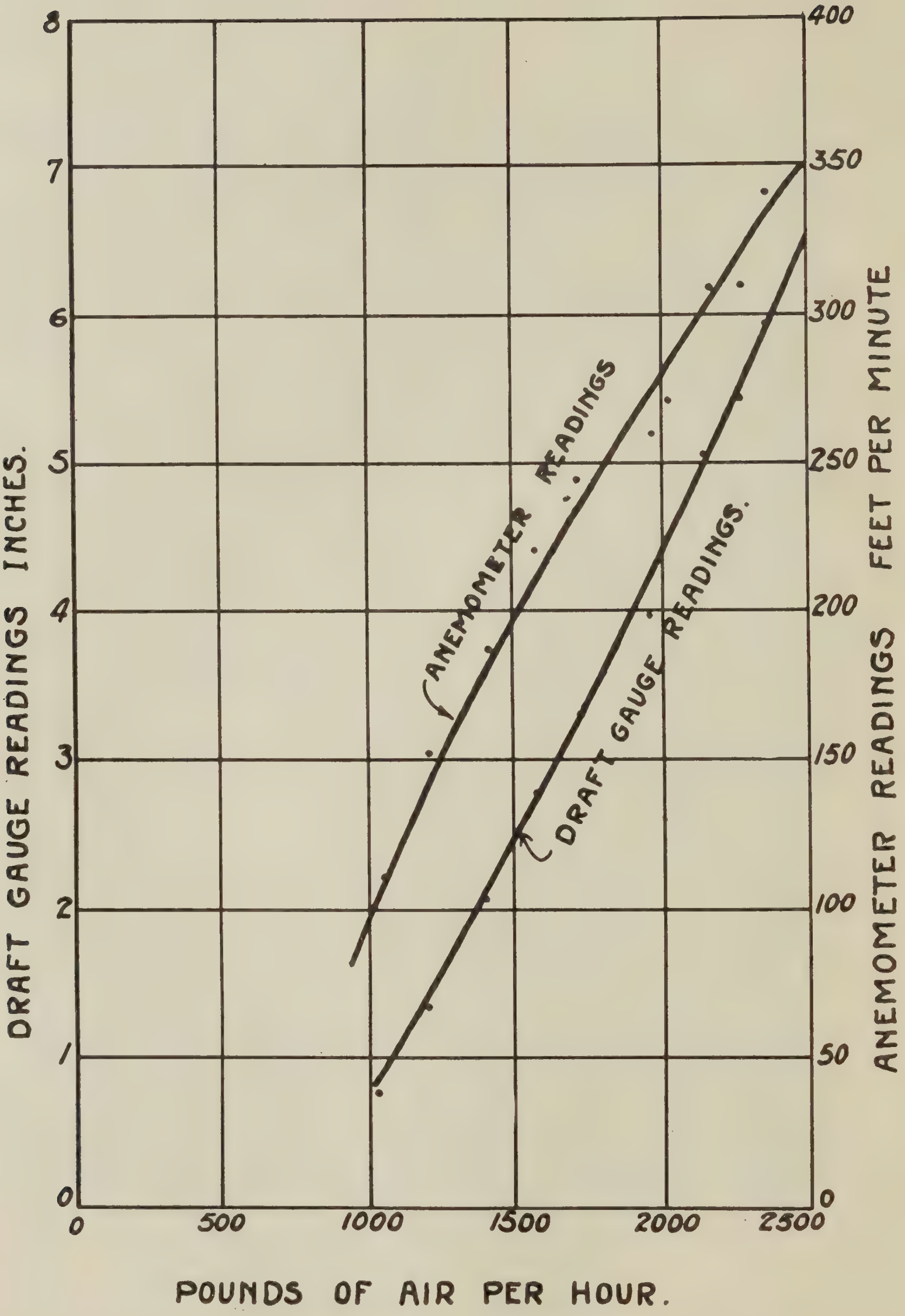


**Figure 5.**—Air Flow through Hot Air Furnace Casing.

and the useful heat distribution would be 70% in the hot air and 30% (by difference) in radiation.

Figure IV shows the percentage of useful heat in the hot air plotted against the pounds of air warmed per effective k.w.h. In order to show justification for the above method of treatment, the percentage of total heat actually lost up the flue is shown for each point of the curve. It will be noted that there is no apparent relation between these flue losses and the position of the corresponding point relative to the mean curve.

The results given in last year's report may be taken as proving the reasonable accuracy of the small (flue) calorimeter for measuring the sensible heat losses in the flue gases. The regularity of the results shown in Fig. 4 indicate also the reliability of the larger calorimeter used for measuring heat in the hot air. Furthermore, the volume of air passing through the casing was calculated from the calorimeter readings in each test. Independent measurements relative to the volume of air passing through the casing were obtained—the readings of the pressure gauge in the air system at the top of the calorimeter, and the readings of an anemometer placed in one of the cold air inlets to the casing. In Fig. 5 these two sets of values are plotted against the calculated air flow. The regularity with which these points lie along a smooth curve is further proof of accuracy.

The higher efficiencies in the third series, shown in Fig. 4 indicate the value of the lining and mat installed to reduce radiation losses.

## RESIDENCE HEATING

Tests were made in an Edmonton residence in January and December, 1924, and in January and February, 1925, to ascertain the normal conditions of flue temperatures, hot air temperatures, and coal consumption in ordinary house heating, for use as a guide when carrying out laboratory tests in warm air heaters. No great accuracy is claimed for them, but nevertheless they are instructive and interesting.

The house chosen was a one and one-half story frame house, approximately 24 by 36 feet outside dimensions. At the time of the first tests it was heated with a 20-inch round pot Canadian Warner hot air furnace. This furnace was too small for the house and also was old. Before the later tests this was changed to a No. 220 Eskimo combination hot air furnace with a 17″x22″, 18″ high fire box for burning coal, and four burners in side compartments for use with natural gas.

Supplementary heating in the house consisted in a coal grate in the living room and a laundry jacket heater in the kitchen. The latter was used for water heating, etc. The jacket heater was converted to gas firing after the first tests.

Three tests were run: A, with the small furnace and coal firing throughout; B, with the Eskimo furnace and the living-room grate coal fired, and the kitchen stove gas fired; C, with the furnace and stove gas fired, and the grate coal fired. It should be par-

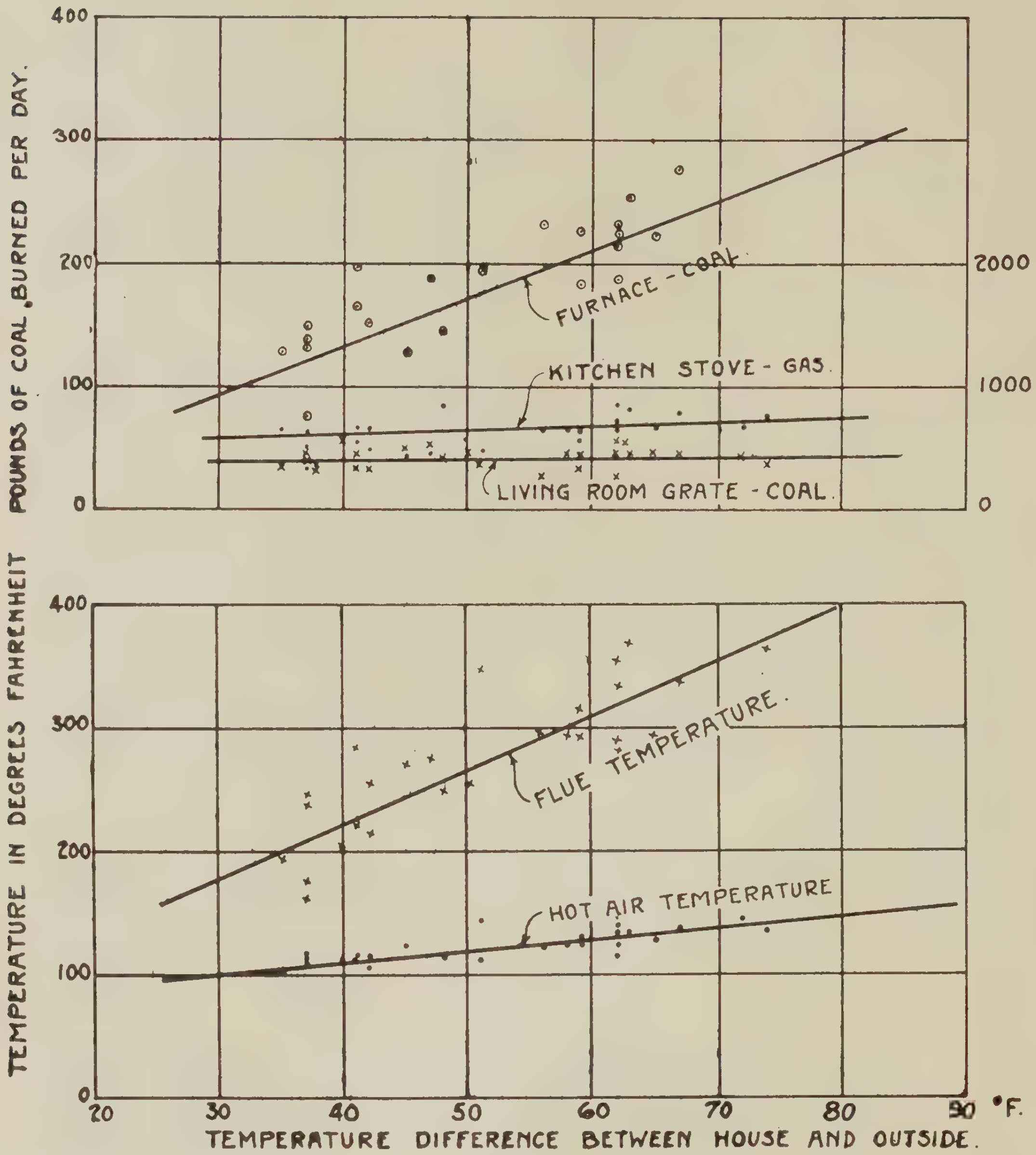


**Figure 6.**—House Heating Tests—Series B.

ticularly noted that such a series of tests as these could not be made accurately without more elaborate precautions than would be convenient in an occupied residence. No record was kept, for example, of wind direction and velocity, or of windows opened each day. It can, however, be stated that, on account of illness, the bedrooms were maintained at a higher temperature during tests B and C than in test A, and probably the house was more ventilated. As the house temperature was recorded only in the dining-room, this is not indicated in the temperature records; so that tests B and C do not show up as well as they otherwise would have done.

Complete records were kept of coal fired, time of firing, ashes removed, water evaporated, etc., in the furnace, and of the coal burned in the supplementary heaters. When gas was used the meter was read at frequent intervals. The temperature of the flue gases, hot air, and house were taken by recording thermometers in all the tests; but in tests B and C two hot air duct temperatures were recorded instead of one, and the outside temperature was also

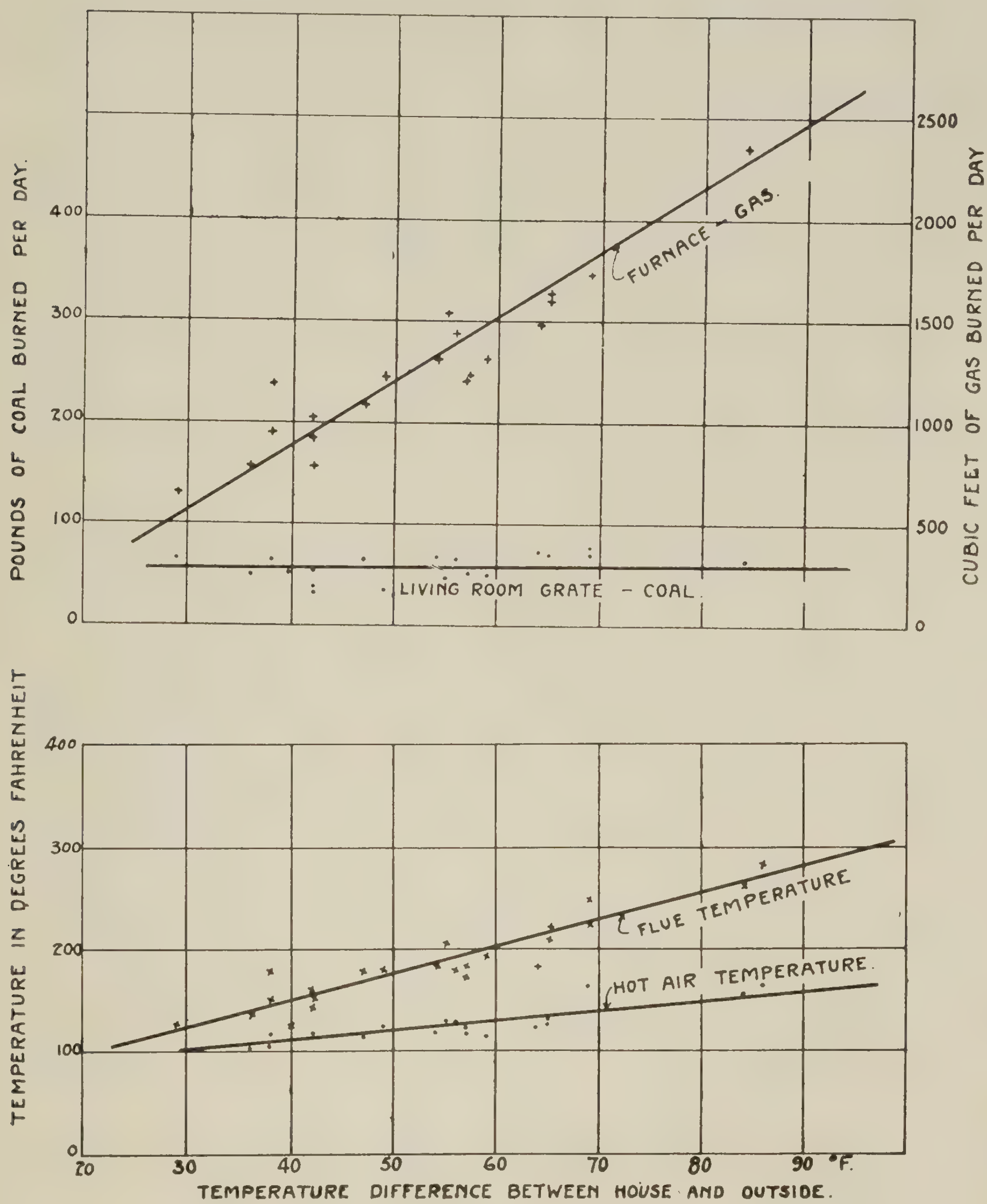


**Figure 7.**—House Heating Tests—Series C.

recorded. In test A this latter temperature was estimated from figures supplied by the weather bureau. The difficulties of accurate measurement of hot air temperatures have been discussed elsewhere in these annual reports. The day, for test purposes, was taken from 6 a.m. to 6 a.m.

The coal burned was sampled daily. The analyses of composite samples follow:

| | Test A | Test B (First 21 days) | Test B (Last 7 days) and Test C |
|---|---|---|---|
| Moisture % | 15.6 | 16.4 | 17.0 |
| Ash % | 12.2 | 12.8 | 14.9 |
| Volatile Matter % | 27.0 | 27.7 | 26.6 |
| Fixed Carbon % | 45.2 | 43.1 | 41.5 |
| Calorific Value, B.T.U. per lb. | 9,570 | 8,990 | 8,730 |

The natural gas was not sampled at the time of the test, but is assumed to have had a calorific value of 885 B.T.U. as measured at the meter. This was estimated to be at 60°F and 27½ inches of mercury pressure.

Charts were prepared to show the total coal and gas consumption for each day, also the average flue gas and hot air temperatures, plotted against the difference between the mean temperature of the house and the mean temperature outside. This chart for test A was given on page 26 of last year's reports, charts for tests B and C are given in Figs. 6 and 7. Fig. 8 shows the results for all three tests with fuel consumption expressed in therms* in order to facilitate comparison between results with the different coals and with gas. Table I gives results taken from the mean curves of Fig. 8, for differences of 40, 60 and 80°F between inside and outside temperatures.

TABLE I.—HOUSE HEATING TESTS, SERIES A, B, AND C.

| No. of Days | Diff. °F. between outside and inside of house | Temperatures °F. | | | Therms Per Day | | | |
|---|---|---|---|---|---|---|---|---|
| | | Flue | Hot Air | Diff. | Furnace | L. R. Grate | Kitchen Stove | Total |
| Canadian Warmer Hot Air Furnace, January, 1924—Coal Firing. | | | | | | | | |
| 20 | 40 | 223 | 109 | 114 | 12.0 | 5.7 | 2.1 | 19.8 |
| | 60 | 322 | 124 | 198 | 20.2 | 7.2 | 2.8 | 30.2 |
| | 80 | 420 | 140 | 280 | 28.5 | 8.6 | 3.7 | 40.8 |
| Eskimo Combination Hot Air Furnace, January, 1925—Coal Firing. | | | | | | | | |
| 28 | 40 | 221 | 109 | 112 | 12.2 | 5.5 | 2.9 | 20.6 |
| | 60 | 310 | 128 | 182 | 19.0 | 6.2 | 3.6 | 28.8 |
| | 80 | 398 | 148 | 250 | 25.9 | 6.7 | 4.0 | 36.6 |
| Eskimo Combination Hot Air Furnace, January and February, 1925—Gas Firing. | | | | | | | | |
| 23 | 40 | 151 | 111 | 40 | 7.5 | 5.7 | 3.0 | 16.2 |
| | 60 | 203 | 131 | 72 | 13.4 | 5.8 | 3.0 | 22.2 |
| | 80 | 256 | 150 | 106 | 19.4 | 5.9 | 2.9 | 28.2 |

It will be noted that, largely no doubt due to the adverse conditions noted above, test B (large furnace) is not quite as good in mild weather as test A (small furnace). The larger furnace, however, did better in colder weather. The higher efficiency of gas firing is clearly shown in spite of the adverse conditions. The full records show clearly that the larger furnace, fired with coal, maintained a steadier temperature in the house and required attention less frequently than the smaller furnace. With natural gas firing, a steady house temperature could be easily maintained.

*A Therm equals 100,000 B.T.U.

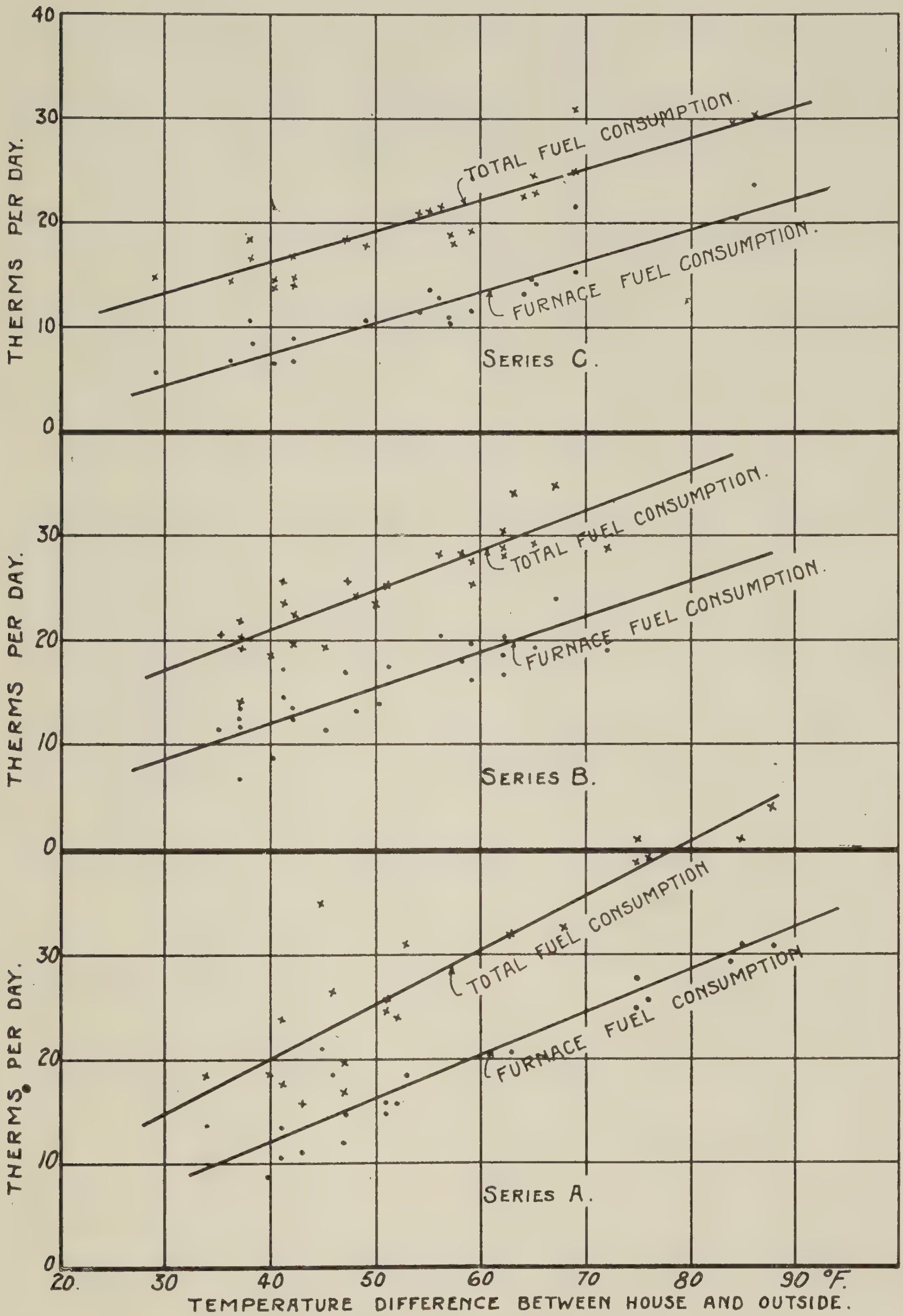


**Figure 8.**—House Heating Tests—Comparison of Series A, B and C.

## Briquetting

The briquetting investigation described in the reports of 1923 and 1924 was continued during 1925 with particular attention to the briquetting of sub-bituminous coal using different asphalts as binder.

Only a brief summary of the work of 1925 is here included, as it is intended to publish a comprehensive report during the coming year on the past three years' work.†

†No funds will be available for this publication before 1927.

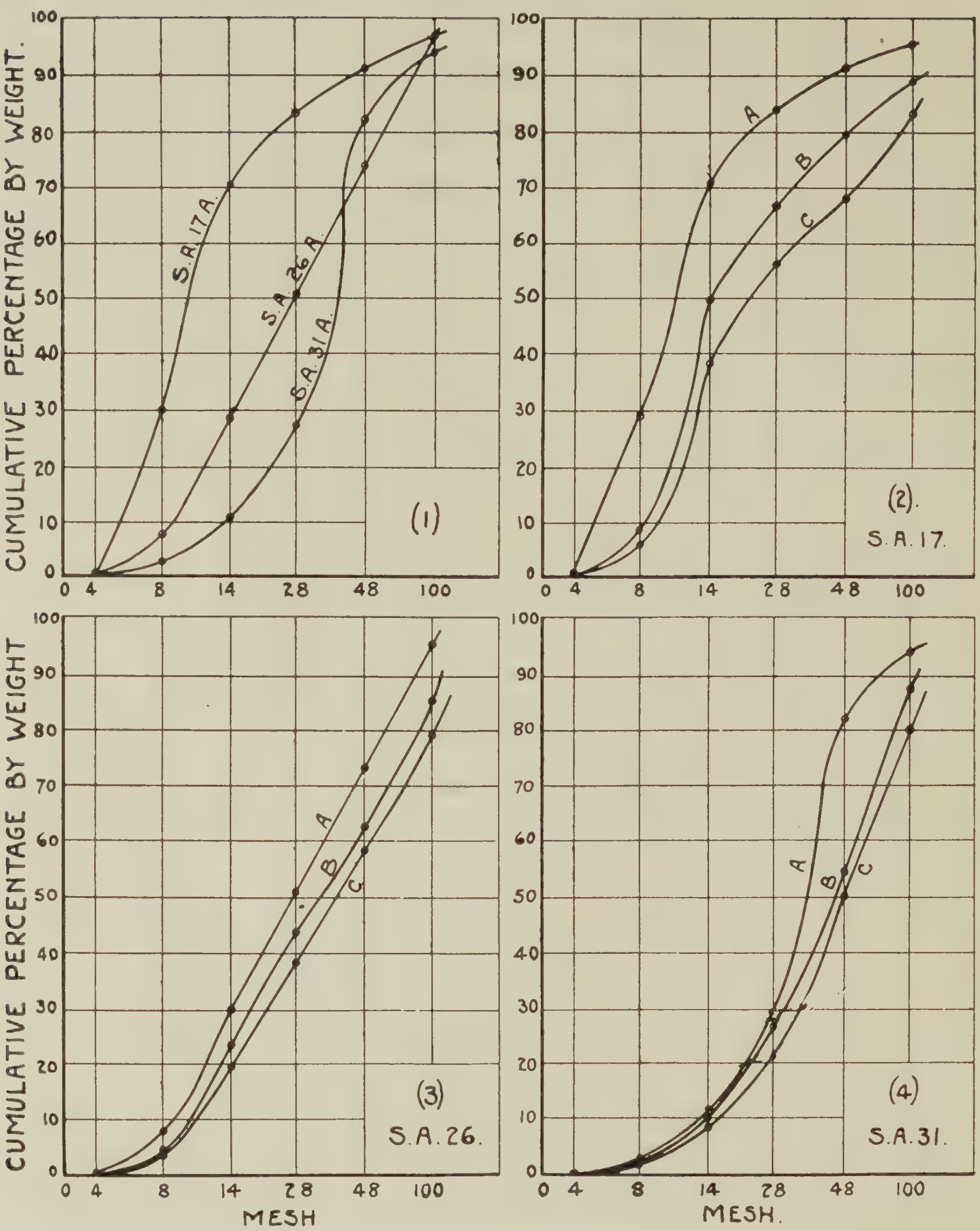


**Figure 9.**—Screen Analyses of Coal.

During the year 211 batches of briquettes were made; classified by coals: semi-anthracite 28, bituminous 3, sub-bituminous 180; classified by binders: soft coal tar pitch 71, asphalt 127, mixed binders 13.

Since the commencement of the briquetting work, 595 batches of briquettes have been made, classified by coals, semi-anthracite 28, bituminous 157, sub-bituminous 370, carbonized lignite 40; classified by binders, soft coal tar pitch 256, hard coal tar pitch 17, lignite pitch 18, asphalt 144, mixed binders 160.

The apparatus used has been described in the Fourth and Fifth Annual Reports.

One change was made from the normal procedure given in the Fifth Annual Report. Thus in practically every case the coal was

crushed to approximately the desired size, screened over Tyler standard screens (on a small shaker screen), and coal of the desired screen analysis then made up by mixing together a suitable weight of each size. This procedure was followed in order to study the effect of sizing of the particles, and to test the effect of other factors under uniform condition with respect to sizing.

Neither the material in the briquette nor even the material as it goes to the press has the original screen analysis, because of the crushing which takes place during mixing and pressing. To determine the extent of this crushing samples were taken of the mix just before going to press, and of the finished briquettes. The binder was extracted from these with benzene and screen analysis run on the coal.

In Fig. 9 are shown typical screen analyses in which cumulative percentages, by weight, retained on each screen are plotted against the mesh opening on a logarithmic scale. Curves A show screen analysis of original coal, curves B of coal after mixing, and curves C of coal after pressing. Fig. 9 (1) compares three typical screen analyses of original coal. Fig. 9 (2), (3) and (4) shows crushing experienced by the coal during mixing and pressing.

The amount of crushing depends upon the sizing and upon the nature of the coal. The tests shown were made on sub-bituminous coal. The same tests made on a friable semi-anthracite gave similar types of curves, although there was more crushing during mixing and pressing.

The results indicate that the best original screen analysis is one which approaches a straight line when plotted on logarithmic paper (see Fig. 9 (1), S.A. 26A), always provided there is not too much coarse or fine coal present. Coarse coal gives a rough briquette from which there is high loss by abrasion, and fine coal requires considerably more binder, due to increased surfaces to be covered.

Table II shows typical results obtained when coals of these screen analyses are briquetted. In this table S.A. stands for screen analysis. The mixing ratio (M.R.) of the binder gives the parts, by weight, of binder added to 100 parts of coal. Good briquettes are indicated by a low loss in the rattler test (% R.L.) and by a low percentage of voids.

Screen analysis No. 26 usually gives briquettes with medium density (apparent specific gravity), but which have a low loss in rattler test. Screen analysis No. 17 gives briquettes with high density and medium rattler loss. Screen analysis No. 31 gives briquettes with low density and high rattler loss.

In general the results obtained with sub-bituminous coal agreed with those obtained during 1924, and showed that strong briquettes can be made with such coal with 6%, or less, of asphalt binder, but the briquettes do not stand up well when thrown upon a hot fire. However, the addition of 10% of finely ground coking coal gave briquettes which would satisfactorily pass firing tests, and also weathering tests.

TABLE II.—BRIQUETTING TESTS WITH SIZED COALS.

| Run | S.A. | Coal Used | M.R. Binder | % R.L. | Specific Gravity | | % Voids |
|---|---|---|---|---|---|---|---|
| | | | | | Apparent | Real | |
| 605 | 26 | Sub-bituminous ...... | 5 asphalt | 7.2 | 1.29 | 1.51 | 14.1 |
| 596 | 17 | " ...... | 5 " | 9.9 | 1.30 | 1.50 | 13.3 |
| 610 | 31 | " ...... | 5 " | 7.2 | 1.22 | 1.48 | 17.4 |
| 621 | 26 | " ...... | 6 pitch | 33.5 | 1.25 | 1.51 | 17.4 |
| 612 | 17 | " ...... | 6 " | 37.5 | 1.28 | 1.51 | 15.0 |
| 626 | 31 | " ...... | 6 " | 37.9 | 1.19 | 1.49 | 20.3 |
| 661 | 26 | Semi-anthracite ... | 6 asphalt | 3.1 | 1.15 | 1.33 | 13.1 |
| 662 | 17 | " ...... | 6 " | 5.9 | 1.17 | 1.33 | 12.1 |
| 663 | 31 | " ...... | 6 " | 7.5 | 1.12 | 1.33 | 15.9 |

The sub-bituminous coals used were high in ash and dirt particles were often observed loosely held at the surface of the briquette. To test the effect of dirt in the coal, one hundred and eighty pounds of sub-bituminous coal was washed on a Wilfley table yielding 72% of clean coal. The original coal contained 23.5% ash, the clean coal 12% ash, and the waste 53% ash.

Briquettes made with the clean and waste coal with 5 parts, by weight, of asphalt binder to 100 parts coal gave the following results:

| Run | Coal | % Rattler Loss | Specific Gravity | | Voids % |
|---|---|---|---|---|---|
| | | | Apparent | Real | |
| 655 | Clean ........................ | 22.5 | 1.100 | 1.143 | 23.0 |
| 656 | Waste ...................... | 4.8 | 1.535 | 1.800 | 14.1 |

The results indicate that the clean coal, on account of its low density, and therefore large volume, requires more binder, by weight, to make a strong briquette. If the binder were expressed as parts per weight of clean coal in both cases, the dirty coal would require notably more binder to make equally good briquettes.

In the study of binders the earlier work with asphalt was not encouraging, because the briquettes, although they lost very little weight in the rattler test, were scarcely hard enough to stand handling, and because the mix stuck to the plunger. During 1925 excellent briquettes were made with asphalt binders and neither of the above difficulties were experienced. The briquettes also passed weathering and firing tests. No satisfactory explanation of this change can be given.

The asphalt used in most of the tests was "Imperial Briquette Binder" from the Montreal refinery of the Imperial Oil Company. It is worth noting that asphalt prepared by steam distillation of crude bitumen extracted from McMurray bituminous sand, and of asphalt similarly prepared from Wainwright crude oil, gave equally good results.

The 1925 tests indicate that asphalt is the best binder yet studied, because of its excellent binding and weatherproofing qualities. They also show that this binder is available within the province of Alberta.

A few tests were made during the year with other binders, such as starch, flour, gluterin, straw, sawdust, etc., mixed with pitch or asphalt. These were found to be inferior in weather resisting properties.

Considerable work has been done with regard to the effect of moisture, temperature of mixing and pressing, time of mixing, physical properties of binders, etc. These results will be given in the full report.

Excellent briquettes were made with semi-anthracite coal from the Cascade area, using 5% of asphalt. They are superior in appearance, give little smoke, are low in ash, and satisfactorily pass the handling, weathering and firing tests.

## GEOLOGICAL SURVEY DIVISION

By JOHN A. ALLAN.

### INTRODUCTION

The compilation of data obtained in 1924, the preparation of maps and reports, and the editing of the same for publication, required considerable time during the first six months of the year. The writer had associated with him Dr. R. L. Rutherford, geologist, who conducted a field survey as described below, prepared Report No. 10 and assisted with the survey duties in the office. Dr. P. S. Warren, Associate Professor in Geology at the University of Alberta, gave freely of his time in the examination of fossil material and on palaeontological questions. His assistance is deeply appreciated.

Dr. E. W. Berry kindly assisted by determining palaeontological material from the Paskapoo formation in Alberta. The results of his studies will be published at an early date.

F. M. Etheridge, G. J. Knighton, L. S. Russell and C. H. Mealing, students at the University of Alberta, gave assistance in the drafting of maps, etc.

The correspondence relating to the Division included 632 letters received and 687 sent out. Requests were received for information on coal, iron, petroleum and natural gas, gypsum, talc, mica, placers, manganese, phosphate, clays, paint earths, water supply, the relation between the source of water supply and distribution of goitre in animals, and many minor subjects related to the natural resources of Alberta.

Approximately one hundred specimens and samples were received with requests for information. Those requiring chemical analysis were forwarded to Mr. J. A. Kelso, Director, Industrial Laboratories. About twenty samples obtained during field work were also analysed in the Industrial Laboratories, and seventy-five samples related to fertilizers were analysed by the Soils Department, University of Alberta.

### PUBLICATIONS FROM THE DIVISION IN 1925

Report No. 11, "Geology of the Foothills Belt between MacLeod and Athabaska Rivers," by R. L. Rutherford.

Map No. 7, in 8 colors, accompanying Report No. 11, by J. A. Allan and R. L. Rutherford.

"Geological Investigations during 1924," by J. A. Allan, part of Report No. 10.

Map No. 8, "Geology of Red Deer Sheet," in 8 colors, by J. A. Allan and J. O. G. Sanderson. (Not yet released.)

Map No. 9, "Geology of Rosebud Sheet," in 8 colors, by J. A. Allan and J. O. G. Sanderson. (Not yet released.)

Map No. 10, "Geological Map of Alberta," by J. A. Allan.

"The relation of the Geology to the Soils in the Macleod sheet," by J. A. Allan, accompanying report by Dr. F. W. Wyatt on "Soil Survey of Macleod sheet."

"Geology of Alberta Coal," by J. A. Allan, Trans. Can. Inst. Min. & Met., Vol. 28, 1925, p. 387.

In March the writer attended the annual meeting of the Canadian Institute of Mining and Metallurgy, in Ottawa, to give a paper on "Geology of Alberta Coal." While in Ottawa he received a kind offer of co-operation with the Topographical Survey of Canada from the Director, Mr. F. H. Peters. This included the use of the plates of Red Deer and Rosebud topographical sheets, and the printing on these maps of geological data obtained by this Division. Valuable aerial photographic survey data were also obtained from the Topographical Survey of Canada which aided the field work of the year. Acknowledgment is also made for the further courtesy of the Director in supplying, for use in 1925, an advance photographic copy of the new Edmonton sheet based on ground and aerial surveys.

The writer also attended the Annual Western Meeting of the Canadian Institute of Mining and Metallurgy in Winnipeg in November. In Winnipeg he arranged final details regarding the publication of the new geological map of Alberta (Map No. 10). Notes on this map are given in another part of this report.

During the year data was compiled and memoranda prepared for the Alberta Coal Commission.

Field work was carried on by two field parties, one for four months under Dr. R. L. Rutherford in the foothills; the other for two weeks by the writer in the Bighorn Basin and along Saskatchewan river. These and other minor investigations are here reported.

## Foothills Survey

The geological survey in the foothills which was started in 1922 at North Saskatchewan river, was continued in 1925. The area surveyed in 1925 includes abut 700 square miles and lies between Embarras, McLeod and Athabaska rivers, or between Coalspur, Bliss and Edson. This is covered in Report No. 15. The correlation of the upper Cretaceous coal-bearing rocks and associated formations had been carried along the foothills belt from Saunders Creek to Athabaska river in the past three years, and in 1925 Dr. Rutherford extended this survey eastward from the foothills as far as Edson. This work will be continued eastward to Edmonton during the season of 1926, and it is hoped that it will be possible to correlate the coal-bearing formation at Evansburg, Wabamun and Edmonton with those along the Alberta Coal Branch south from Coalspur and at other points in the foothills.

Many important stratigraphical problems have been encountered during the surveys in the past four years, but one of the most outstanding problems is the relation of the *Saunders* formation, which is coal-bearing, with the *Edmonton* formation, which contains several coal seams in Central Alberta. Determination of the western

boundaries of the Paskapoo and Edmonton formations is another problem that it is hoped will be worked out with another season of field work.

The accuracy of the geological mapping has been limited by the lack of topographical maps. The topography has been sketched in by Dr. Rutherford where needed for mapping the geology. It is, of course, to be expected that when the topography has been mapped in detail, the position of certain geological boundaries may require revision, although the structural details will be more accurate.

During the past season transit traverses were made along McLeod river through the unsurveyed area as far as the mouth of Gregg river. Control points were also established in the unsurveyed area south-west of Bliss. The rock outcrops throughout the area surveyed were located, and these will be shown on the map which will accompany the report (Report No. 15). Dr. Rutherford has been able to work out certain relations between the coal seams mined at Balkan and Bryan mines near Coalspur with those prospected on McPherson creek. He has also obtained valuable data on the probable extension of these coal horizons north-west across the area into Athabaska valley.

## Blackstone Gap and Bighorn Basin

The writer spent a week investigating the structural relations between the Bighorn mountains at Blackstone gap and the Mesozoic rocks in the Bighorn Basin. He was accompanied on this trip by R. Lamb and Dr. H. M. Tory.

Blackstone gap is formed in the westward dipping Palaeozoic rocks of Carboniferous and Devonian ages in the Bighorn range. The geological section was measured and examined upwards from the top of the Upper Banff Limestone formation.

At the west side of the gap the Rocky Mountain quartzite is represented on the river section by 73 feet of beds dipping at 40 degrees to the south-west. The rocks in this formation are all siliceous, but white quartzite with cherty fragments, and black quartzite that breaks into angular fragments, predominate.

Overlying the quartzite formation is a shale formation which is readily correlated with the Upper Banff shale in the Bow river section. The formation is of Triassic age. Along Blackstone river where the section is best exposed, the formation has a thickness of 540 feet, and the dip is 40 degrees to the west. The contact between the quartzite and shale formation is exposed on the mountain side on the north side of the gap. This is the only locality north of the International Boundary line where the writer has observed this contact.

The formation on the top of the quartzite consists of calcareous shales, and shaly limestones, some of which are cream coloured and porous. This part of the section is very similar to the section of Upper Banff shale exposed in Spray canyon below the lower Spray lake south of Banff.

White, porous, thin-bedded limestone, speckled limestone, brown dolomite and dolomite shale are also common. Only a very few feet of black shale were observed in this formation. The trend of these beds is north 60 to 68 degrees west, and the dip from 35 to 42 degrees south-west.

*Fernie Shale.*—In Blackstone gap the Upper Banff Shale formation is overlain by the Fernie formation. A section was measured in the head of the small valley entering Blackstone river from the north and directly opposite the valley of George creek.

The entire section of the Fernie is approximately as follows:

| | |
|---|---|
| Black shale and brown sandstone interbedded | 175 feet |
| Black shale | 125 " |
| Hard dark grey shale | 9 " |
| Black shale, soft | 50 " |
| Clay ironstone bands interbedded with shale | 10 " |
| Black shale with 12 clay ironstone bands each about 4 inches thick and several fossil horizons | 58 " |
| Black hard argillaceous quartzite with numerous belemites and other mollusca | 8 " |
| Black quartzite sandstone (at falls) | 35 " |
| Black shale, many beds one inch thick | 125 " |
| Soft black shale forming black soil | 65 " |
| Hard calcareous sandstone interbedded with shale, at least | 25 " |
| Total | 685 feet |

The central part of the Fernie formation is exposed as a continuous section in the creek opposite George creek and on the north side of Blackstone valley. A small waterfall has been formed where the creek cuts across the quartzose sandstone and the underlying belemites zone. It is common to find blocks of this upper zone made up almost entirely of these fossils. From this zone and the beds immediately above the following fossils have been determined by Dr. P. S. Warren:

*Belemites* cf. *densus* Meek & Hayden.
*Trigonia* sp. nov.
*Inoceramus* sp. nov.
*Plagiostoma* sp. nov.
*Cyprina*, sp. nov.
*Pleuromya* sp. undet.

The upper and lower members in this formation are exposed on the two sides of the valley of George creek. The basal beds outcrop at a few places on the east side of the valley which is heavily wooded. In one exposure at the head of a small draw entering George creek near its mouth, the very black Fernie shales include bone fragments and pyrite nodules. The bones observed were too fragmental for determination. One vertebrae 3 inches in diameter was collected. It is marine reptilian, and is believed to be from plesiosaur or ichthyosaur. These beds give a pronounced phosphatic reaction when tested, but some beds have a higher content than others.

The uppermost beds in this formation are exposed on the west side of the valley of George creek. Brown sandstone, ferruginous sandy shale and dark shales predominate.

*Kootenay Formation.*—It is very difficult to map the boundary between the Fernie and Kootenay formations. There appears to be a transition from true marine Fernie beds into true Kootenay of fresh water origin. About two and a half miles up George creek there is a knob on the west side of the valley which consists of massive black and dark grey sandstones overlain by 25 feet of fine conglomerate. The pebbles are well rounded, many are greenish in color, and the cement is siliceous. These beds have a strike of north 60 degrees west, and dip 35 to 40 degrees south-west. Below the conglomerate, in addition to the black sandstone, there are brown sandstones, sandy shales and coaly shale. The writer is of the opinion that the base of the Kootenay near the mouth of George Creek occurs about 500 feet below the base of the conglomerate. On account of the westward dip of the formation, the Kootenay beds cover the face of the spur ridges on the east side of George creek. The contact between the Kootenay and Fernie occurs on Smith creek about three miles above the junction of Smith creek and Blackstone river.

Malloch*, who in 1908 examined the geological structure and made a photo-topographic survey of the Bighorn basin, measured the Kootenay section, and found it to be 3,659 feet thick.

In 1906 Dr. D. B. Dowling made the first discovery of coal in the Bighorn basin. He examined the geology of this basin in 1907 and discovered nine workable seams of coal with an aggregate thickness of 66 feet. In the following year Mr. James McEvoy made a very detailed examination of the Kootenay formation in the Bighorn basin for the German Development Company. He determined fourteen coal seams with a total thickness of 89 feet. Of these he regarded eight seams as workable, with an aggregate thickness of 60 feet of coal. On George creek the thickest coal seam, according to Mr. McEvoy is 12 feet. The analysis was as follows:

| | | |
|---|---|---|
| Moisture | % | 0.56 |
| Ash | % | 6.32 |
| Volatile Matter | % | 22.82 |
| Fixed Carbon | % | 70.30 |

The observations of McEvoy, Malloch and Dowling have proven that there is an extensive deposit of high-grade bituminous coal with excellent coking qualities in the Bighorn basin.

The object of the present study was not to examine the Kootenay formation in particular, but to make some observations on the relation of the various formations along Blackstone river from the Carboniferous to the Kootenay.

## SASKATCHEWAN RIVER SECTION

It was the intention of the writer to examine and measure the section exposed along North Saskatchewan river between Rocky Mountain House and Edmonton.

*Malloch, G. S. Geol. Surv. Can., Memoir 9 E, 1911.

In order to facilitate this work aerial photographs were taken along this section by the Royal Canadian Air Force operated in conjunction with the Topographical Survey of Canada and following a request from the writer to the Minister of the Interior.

A boat was built at Rocky Mountain House and the trip began on August 11th. Owing to an unfortunate boat accident near the mouth of Baptiste river, almost the entire outfit was lost including all instruments, maps and photographs, so that the river trip was abandoned. It is the intention to complete this examination at a later date, and another set of the aerial photographs has been obtained. The writer wishes to record the great value of the aerial photographs in making geological observations on that part of the section that was completed before the accident.

### Use of Aerial Photographs

In addition to the aerial photographs along the North Saskatchewan to which reference is made above, the writer, through the kindness of the Royal Canadian Air Force, has obtained the use of over one thousand photographs of much of the unsurveyed territory west of North Saskatchewan river in the vicinity of the mouth of the Brazeau and Nordegg rivers and north to the Pembina.

These photographs are now being used in plotting out the position of rock outcrops in that district, which is largely wooded or covered with muskegs. Aerial photographs are of real value to the geologist in reconnaissance surveys of country where rock outcrops are few and difficult to locate.

Thanks are expressed to the Royal Canadian Air Force and to the Topographical Survey of Canada for their co-operation in this respect. Their efforts in this part of Alberta are greatly appreciated.

A flight was made with Flying Officer A. A. Carter, from the flying field at High River westward over the foothills and the Turner Valley oil field. When flying at low altitude and with proper light conditions, much structural information can be obtained on the geology of a district that might be overlooked on a ground survey.

### Coal on Highwood River in Foothills

In section 8, township 18, range 3, west of the 5th meridian, coal seams have been opened by wagon mines on the south side of Highwood river about 25 miles west of the town of High River. A brief visit was made to these mines to determine the horizon in which the coal seams occur. The coal is in Belly river rocks, and both folding and faulting of the beds are apparent, although this district is 20 miles east of the front of the Rocky Mountains.

In one mine there is a nine-foot seam of coal opened by a slope. The dip is about 80 degrees. On the south side of Coal Creek in the same section a coal seam has been reached at 85 feet from the surface. The coal is 16 feet thick with a local thickening by pressure to 25 feet. The coal and enclosing strata are dipping nearly vertically.

A shaft was being sunk a few yards south on the same section and further from the coulee. The coal had not been reached at the time of the visit. The output from this district in 1924 was about 3,000 tons.

The coal from this district is semi-bituminous. A representative analysis of this coal is as follows:

| | |
|---|---|
| Moisture | 8% |
| Ash | 10% |
| Volatile matter | 36% |
| Fixed Carbon | 46% |
| Calorific Value (B.T.U.) | 11,450 to 12,350 |
| Fuel Ratio | 1.25 to 1.35 |

### LOWER CRETACEOUS COAL AT WAINWRIGHT

When drilling for oil four miles north of Wainwright in 1924, the British Petroleums, Limited, passed through a seam of coal in No. 3 well between 2,208 and 2,217 feet. This well is located in the south-west corner of legal subdivision 4, section 29, township 45, range 6, west of the 4th meridian.

The log of this part of the well, as supplied by the Company, is as follows:

| | |
|---|---|
| 2,188 —2,190 | hard coarse sand. |
| 2,190 —2,200 | grey sand with streaks of shale. |
| 2,200 —2,208 | grey shale. |
| 2,208 —2,217 | COAL. |
| 2,217 —2,222 | sticky grey shale. |
| 2,222 —2,223.8 | black shale with sand. |
| 2,223.8—2,224.8 | hard grey lime. |

Another small showing of coal appears in the log at 2,228 feet. The writer did not see any of the coal from this well, as he was informed that the samples had been sent to Ottawa.

The same Company drilled well No. 3B about one hundred feet east of No. 3 in the same legal subdivision. The log of the coal horizon as supplied by the Central Alberta Oil Association, and taken from the official log compiled in Ottawa, is as follows:

| | |
|---|---|
| 2,205—2,207 | dark grey shale. |
| 2,207—2,211 | black highly carbonaceous shale. |
| 2,211—2,215 | very black grey carbonaceous shale. |
| 2,215—2,219 | black very carbonaceous shale, coal partings. |
| 2,219—2,222 | grey shale coal and shaly coal partings. |
| 2,222—2,225 | light brown grey sand, shale partings. |

Four samples of the boring from the coal horizon, marked 2,209—2,216 feet, were supplied by Mr. T. Sugars, Field Manager of the British Petroleums, Limited, and were analysed by Mr. W. P. Campbell, of the Fuels Division. The analysis, with the description of each sample submitted is as follows:

*Lab. Sample No.* 411-25.

Core sample from B.P. No. 3B well. Sample taken from upper 4 feet of seam as shown by borings at depth of 2,209-2,216 feet.

| | %As received | % Air Dried | % Dried |
|---|---|---|---|
| Moisture | 17.0 | 15.7 | ........ |
| Ash | 6.4 | 6.5 | 7.7 |
| Volatile matter | 29.7 | 30.2 | 35.8 |
| Fixed Carbon | 46.9 | 47.6 | 56.5 |
| Calorific value, gross B.T.U. per lb. | 10,080 | 10,230 | 12,140 |
| Fuel Ratio | | 1.60 | |

*Lab. Sample No.* 412-25.

From upper part of seam.

| | | | |
|---|---|---|---|
| Moisture | 11.2 | 11.2 | ........ |
| Ash | 31.8 | 31.8 | 35.8 |
| Volatile matter | 24.7 | 24.7 | 27.8 |
| Fixed carbon | 32.3 | 32.3 | 36.4 |
| Calorific value, gross B.T.U. per lb. | 7,370 | 7,379 | 8,300 |
| Fuel Ratio | | 1.30 | |

*Lab. Sample No.* 413-25.

From middle of seam.

| | | | |
|---|---|---|---|
| Moisture | 15.9 | 15.1 | ........ |
| Ash | 16.5 | 16.7 | 19.7 |
| Volatile matter | 25.6 | 25.8 | 30.4 |
| Fixed carbon | 42.0 | 42.4 | 49.9 |
| Calorific value, gross B.T.U. per lb. | 8,670 | 8,750 | 10,310 |
| Fuel Ratio | | 1.65 | |

*Lab. Sample No.* 414-25.

From bottom of seam.

| | | | |
|---|---|---|---|
| Moisture | 14.2 | 13.6 | ........ |
| Ash | 35.1 | 35.4 | 40.9 |
| Volatile Matter | 23.1 | 23.2 | 26.9 |
| Fixed carbon | 27.6 | 27.8 | 32.2 |
| Calorific value, gross B.T.U. per lb. | 6,360 | 6,400 | 7,410 |
| Fuel Ratio | | 1.20 | |

The last three analyses indicate that these samples are coaly shale rather than coal. The quality of the coal in this horizon is shown in sample No. 411-25. The coal is a good grade of lignite.

This coal horizon occurs below the Colorado marine shales, so that it must be classed as lower Cretaceous in age. The shale in which the coal occurs corresponds in age to the Kootenay in the foothills and mountains of Alberta. This coal occurrence near the eastern side of Alberta does not indicate that the Kootenay beds extend all the way across Alberta from the mountains to Wainwright. It is more likely that these lower Cretaceous strata at Wainwright can be correlated with the Clearwater or Grand Rapids formation that are of the same age and outcrop along Athabaska river from Grand Rapids to McMurray.

The assumption is that the coal-bearing strata at Wainwright were deposited in a lower Cretaceous sea that extended from the McMurray district southwards in the eastern side of Alberta. It is quite probable that these lower Cretaceous rock extend much further south than Wainwright.

In Imperial No. 1 well at Fabyan, in section 18, township 45, range 7, west of the 4th meridian, coal fragments are recorded in the log of the core at 2,080-2,100 feet, and again between 2,110-2,120 feet. These coal horizons are also in the lower Cretaceous strata.

The occurrence of coal in eastern Alberta is of no commercial importance as a source of coal, but this horizon is a particularly good marker in drilling the strata for oil. Those drilling in eastern central Alberta would be well advised to watch for this horizon marker in the core samples, because the comparative position of the coal in several wells would probably give valuable information on the underlying structure in the strata within a limited area.

The analysis of the coal at Wainwright illustrates clearly the effect of age and pressure in determining the quality of a coal.

The Wainwright coal is lower Cretaceous in age and is of the same age as the Kootenay coal along the east side of the Rocky mountains. Wainwright is 270 miles due east of Mountain Park, so that the rocks in eastern Alberta have not been matured to the same extent as those that have been subjected to mountain building pressure. The coal at Mountain Park is a high grade bituminous with 3 per cent. moisture, whereas the coal of approximately the same age at Wainwright is a lignite with 17 per cent. moisture.

These observations explain why the quality of coal in the same horizon increases from the east to the west and towards the mountains. Some of the coal in the Edmonton formation in the Carbon area is of higher quality with lower moisture content than the lower Cretaceous coal at Wainwright, although the coal in the Edmonton formation is very much younger.

## AVAILABLE COAL SUPPLY

On the request of the Alberta Coal Commission, the writer has endeavoured to compile data on the available coal supply in Alberta. The results of this study were submitted to the Coal Commission early in 1925. The data obtained for this purpose have been reconsidered and slightly revised, and the tabulation given below has been prepared. Hence the inclusion of the following notes.

It is not the intention to discuss the coal resources within Alberta, as this would require not only a much more extended study of the data already published, but more detailed field investigations in many of the coal areas where geological information is very meagre.

A clear distinction must be made between *coal resources*, *coal reserves* and *available coal supply*. In the opinion of the writer, any estimation of coal resources must include all known coal deposits, but it must be evident that a part and possibly a large percentage of coal is not mineable in the deposits. Any estimate of the resources will be much larger than an estimate of the amount of coal that can be classed as mineable. An estimate of coal reserves, on the other hand, must represent the quantity of coal that may be mineable at present or at some future date. This estimate will be considerably smaller than that given for the coal resources.

In this report the coal deposits are classed under two groups.

The available coal supply refers to the quantity of coal in seams that are considered to be workable. This estimate should be based on data obtained by mining development and by detailed geological field surveys of coal-bearing horizons. An attempt has been made to compute the Alberta coal supply on this basis.

After several years of field investigations, Dr. D. B. Dowling published an exhaustive memoir on the coal resources of Alberta.* Group I includes seams of one foot and over, to a depth of 4,000 feet. Group II includes coal seams two feet and over between 4,000 and 6,000 feet in depth. This basis of classification has been accepted by all countries throughout the world in compiling coal resources. Dr. Dowling at no time stated that the figures he gave for the coal deposits of Alberta included only the amount of coal that was mineable.

According to this method of compilation, the area underlain by coal in each of the three coal-bearing horizons in Alberta is as follows:

| | Actual. | Probable. |
|---|---|---|
| | GROUP I | |
| Kootenay | 65 square miles | 711 square miles |
| Belly River | 15,300 square miles | 25,974 square miles |
| Edmonton | 9,590 square miles | 20,340 square miles |
| | GROUP II | |
| Undivided | 203 square miles. | |

The total coal resources of Alberta computed on the basis of the areas noted above has been given at 1,072,400,000 metric tons.

This figure has been quoted frequently as representing the available coal supply in Alberta. Many have objected, and rightly so, to the use of this figure when referring to the amount of coal awaiting development. Nevertheless, the figure given by Dr. Dowling for the coal resources of Alberta must be retained for comparison with the coal resources of other countries computed in the same way.

In 1925 the writer made an estimate of the actual and probable coal reserves that might be regarded as an asset to Alberta.† This estimate was based on data available at that date on the actual and probable coal lands in each of the coal areas to a depth of about 1,000 feet, and on seams over two feet in thickness.

A summary of these results is as follows:

| | | Sq. Miles. | Metric Tons. |
|---|---|---|---|
| Kootenay | Bituminous coal | 972 | 41,368,320,000 |
| Belly River | Sub-bituminous | 2,880 | 52,531,200,000 |
| Belly River | Lignite | 3,996 | |
| Edmonton | Lignite | 5,616 | 233,763,840,000 |
| | Total coal reserves | | 327,663,360,000 |

*Dowling, D. B. Geol. Surv. Can., Memoir 59, 1915.
Dowling, D. B. Coal Reserves of World, Vol. 2, 1912.

†Allan, J. A. "Geology of Alberta Coal", Trans. Can. Inst. of Min. & Met., Vol. 28, 1925, p. 387.

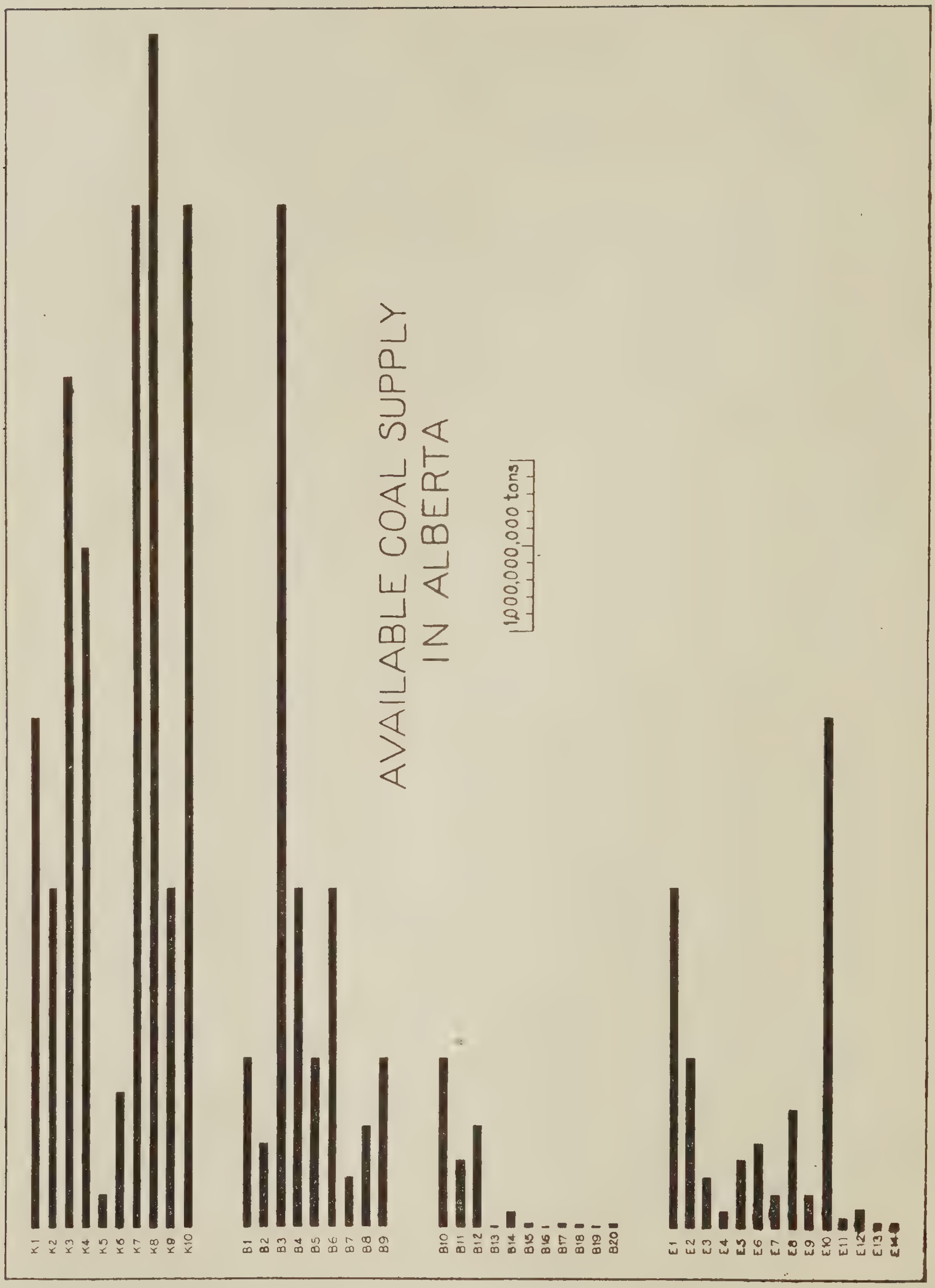


**Figure 10.**—Available Coal Supply in Alberta.

Even this figure is high when it is the available tonnage that is being considered.

As it was necessary to consider in detail the extent of coal lands for the Alberta Coal Commission in 1925, the writer reviewed all published data on the coal deposits in Alberta, and estimated the amount of coal available for production in each coal area.* Where possible the sections or fractions of sections were tabulated for each area in order to determine the extent of the available coal. Seams over two feet in thickness and within about 1,000 feet of the surface have been considered. The tonnage is given in short tons, and computed on the following basis:

| | |
|---|---|
| Bituminous | 1,800 tons per acre foot. |
| Sub-bituminous | 1,700 tons per acre foot. |
| Lignite | 1,600 tons per acre foot. |

In some of the coal areas there is very little information on the extent of the coal seams, but it is the opinion of the writer that the total estimate given here is quite conservative.

Fig. 10 accompanying this report gives in graphic form the available coal in each of the coal areas. These estimates are also shown in Table III.

Table III.—Available Coal Supply in Alberta.

| Coal Area. | Square Miles. | Thickness in feet. | Tonnage. |
|---|---|---|---|
| I.—*Bituminous Coal—Kootenay Formation.* | | | |
| K 1—Smoky River | 55 | ...... | 3,000,000,000 |
| K 2—Brule | 36 | 45 | 2,000,000,000 |
| K 3—Mountain Park | 108 | 40 | 5,000,000,000 |
| K 4—Nordegg | 46 | 27 | 4,000,000,000 |
| K 5—Clearwater | 18 | ...... | 200,000,000 |
| K 6—Panther | 11 | ...... | 800,000,000 |
| K 7—Cascade | 140 | 40 | 6,000,000,000 |
| K 8—Highwood | 90 | 70 | 7,000,000,000 |
| K 9—Oldman | 72 | 30 | 2,000,000,000 |
| K 10—Crowsnest | 180 | 30 | 6,000,000,000 |
| Total | | | 36,000,000,000 |
| II.—*Sub-Bituminous Coal—Belly River (Saunders) Formation.* | | | |
| B 1—Halcourt | 72 | 15 | 1,000,000,000 |
| B 2—Prairie Creek | 25 | 20 | 500,000,000 |
| B 3—Coalspur | 140 | 49 | 6,000,000,000 |
| B 4—Saunders | 72 | 20 | 2,000,000,000 |
| B 5—Morley | 90 | 20 | 1,000,000,000 |
| B 6—Pekisko | 100 | 30 | 2,000,000,000 |
| B 7—Pincher | 36 | 8 | 300,000,000 |
| B 8—Magrath | 72 | 8 | 600,000,000 |
| B 9—Lethbridge | 180 | 6 | 1,000,000,000 |
| Total | | | 14,400,000,000 |

*Report No. 10, S. & I.R.C. of Alberta, 1923, p. 55, Coal Areas of Alberta.
Report No. 12, S. & I.R.C. of Alberta, 1924, p. 44, Coal Areas of Alberta.

III.—*Alberta Lignite (Domestic) Coal—Belly River (Saunders).*

| | | | |
|---|---|---|---|
| B 10—Milk River | 100 | 10 | 1,000,000,000 |
| B 11—Pakowki | 41 | 10 | 400,000,000 |
| B 12—Taber | 100 | 6 | 600,000,000 |
| B 13—Redcliff | 1 | 5 | 5,000,000 |
| B 14—Brooks | 36 | 5 | 100,000,000 |
| B 15—Steveville | 3 | 5 | 10,000,000 |
| B 16—Empress | 1 | 5 | 5,000,000 |
| B 17—Wainwright | 2 | 10 | 10,000,000 |
| B 18—Pakan | 2 | 10 | 15,000,000 |
| B 19—Rochester | 1 | 5 | 5,000,000 |
| B 20—Sexsmith | 2 | 10 | 20,000,000 |
| Total Lignite (Belly River) | | | 2,170,000,000 |

IV.—*Alberta Lignite—Edmonton Formation.*

| Coal Area. | Square Miles. | Thickness in feet. | Tonnage. |
|---|---|---|---|
| E 1—Pembina | 72 | 35 | 2,000,000,000 |
| E 2—Edmonton | 90 | 15 | 1,000,000,000 |
| E 3—Tofield | 20 | 20 | 300,000,000 |
| E 4—Camrose | 7 | 20 | 100,000,000 |
| E 5—Castor | 30 | 20 | 400,000,000 |
| E 6—Ardley | 15 | 50 | 500,000,000 |
| E 7—Big Valley | 7 | 30 | 200,000,000 |
| E 8—Carbon | 33 | 21 | 700,000,000 |
| E 9—Sheerness | 17 | 15 | 200,000,000 |
| E 10—Drumheller | 200 | 18 | 3,000,000,000 |
| E 11—Gleichen | 4 | 20 | 60,000,000 |
| E 12—Champion | 10 | 15 | 110,000,000 |
| E 13—Wetaskiwin | 2 | 20 | 30,000,000 |
| E 14—Whitecourt | 2 | 20 | 30,000,000 |
| Total Lignite (Edmonton) | | | 8,630,000,000 |
| | | | 2,170,000,000 |
| Total Alberta Lignite | | | 10,800,000,000 |

| | |
|---|---|
| Bituminous coal | 36,000,000,000 tons |
| Sub-bituminous coal | 14,400,000,000 " |
| Alberta Lignite | 10,800,000,000 " |
| Total available coal reserve | 61,200,000,000 tons |
| Assuming approximately 50% recoverable | 30,000,000,000 " |

## GEOLOGICAL MAP OF ALBERTA

The need of a geological map of Alberta has been apparent for some years. Several excellent maps by Dr. D. B. Dowling and other geologists have been published by the Geological Survey of Canada, but all of these maps include only small areas in the southern half of Alberta and the adjoining provinces of Saskatchewan and British Columbia.

The first geological map of the whole of the province of Alberta was published by the Scientific and Industrial Research Council of Alberta in December, 1925, as Map No. 10.

The compilation of the base map was commenced by the writer in 1923. The geographical, topographical and geological data shown on the published map have been compiled from all the latest available information obtained by federal and provincial surveys and also private geological investigations. Dr. R. L. Rutherford assisted in plotting the geological boundaries within the foothills.

The map is published on a scale of one inch to 25 miles and is printed in fourteen colors. Fig. 11 (loose insertion) shows the distribution of the geological formations. This is only a key to the published map.

The township and range lines and the base lines are shown in solid lines where surveyed, and in dotted lines in unsurveyed areas. The rivers are shown according to the latest surveys available. It will be noted that the locations of the Brazeau and Pembina rivers in township 45, range 18, west of the fifth meridian differ from those on other published maps.

The topography within the mountains has been shown only where surveys have been made. The topography along the entire length of the interprovincial boundary within the mountains has been surveyed, but with the exception of the district around Yellowhead Pass, the data north of Bow Pass was not available. A map of this scale can only show 1,000-foot contour intervals within the mountains, and 500-foot intervals east of the mountains.

When mapping the geological formations an attempt was made to bring the information up to date. Many changes will be noticed in the position of geological boundaries when compared with other geological maps.

Accurate geological information on the distribution of formations over more than three quarters of the whole province is still lacking. This is particularly true with respect to the boundaries of geological formations. Even since this map went to press, geological data have been obtained, especially along Bow River, particularly west of Calgary, which will necessitate some small changes in the position of certain boundaries. It is hoped that those making use of the map will realize this difficulty in so far as the boundaries or formations are concerned.

No attempt has been made to subdivide the Palaeozoic rocks, because only a very small part of the geology of the Rocky Mountains has yet been mapped in detail.

With the exception of a few fragmentary sections along parts of some of the larger rivers, no attempt has yet been made to subdivide the upper Cretaceous formation in the northern half of Alberta. This accounts for such a large area of color designating the upper Cretaceous.

The Bearpaw formation is known to thin out about the latitude of North Saskatchewan river, but the eastern boundary of this formation in the vinicity of Red Deer and South Saskatchewan rivers may have to be extended some distance eastward when more detailed geological observations have been made.

The western boundary of the Edmonton formation north of Bow river has not yet been defined.

Considerable change has been made in the mapping of the Paskapoo formation north of township 54.

*Erosion Residuals.*—It is not the intention to discuss the physiography of Alberta, but the writer wishes to draw attention to three prominent erosional residuals east of the foothills. These are:

(1) *Cypress Hills* in south-eastern Alberta, in townships 7 and 8, ranges 1, 2 and 3, west of the 4th meridian. Elevation 4,520 feet.

(2) *Hand Hills* east of Drumheller, in townships 28, 29 and 30, ranges 15, 16 and 17, west of the 4th meridian. Elevation 3,575 feet.

(3) *Swan Hills* south of Lesser Slake Lake, in townships 66 to 70 inclusive, ranges 7 to 14 inclusive, west of the 4th meridian. Elevation 4,250 feet.

The tops of these erosion residuals have not been glaciated and they represent the pre-glacial plain level. The Hand Hills are more maturely dissected and are, therefore, lower than the other two. There may be other unglaciated residuals in Alberta east of the mountains, but these have not yet been recorded.

# ROAD MATERIALS DIVISION

By K. A. Clark and S. M. Blair.

## Introduction

The general study of the bituminous sands and their use as road material was continued during 1925. The semi-commercial separation plant at the Dunvegan Yards was remodelled and about 500 tons of bituminous sands successfully treated. The separated bitumen so obtained was utilized in the construction of 3,500 feet of experimental bituminized earth road surface. For comparative purposes, 2,000 feet of similar road surface was constructed using Wainwright crude oil.

## Bituminous Sand Separation

The separation project was completed successfully.

Following encouraging results from laboratory studies, a separation plant for batch runs of several tons of bituminous sand was constructed in 1923. This plant was a success and, as a consequence, it was decided that the separation work should be carried forward to the semi-commercial stage.

A plant to treat one ton per hour of bituminous sand in continuous operation was designed during the winter of 1923-4. A location for the new plant was obtained at the Dunvegan Yards—the Edmonton terminus of the Alberta and Great Waterways Railway. This site was selected in preference to one at Waterways, in the bituminous sand area, on account of the experimental nature of the work. The plant was built during the spring and summer of 1924. Its design was similar to the plant of 1923, but the box in which the bituminous sand was treated with silicate of soda solution was arranged to provide a constant supply of treated material. The plant was put into operation during the late summer and fall, and about 100 tons of bituminous sand were separated. Difficulties encountered showed that the design of the treatment section of the plant was faulty and needed revision. Plant operations were discontinued during the winter.

A simple separation plant was assembled in the laboratory. Its operation during the winter gave the information needed for modifying the larger plant.

Remodelling of the large plant was started in April and completed in May. Trial runs showed that the changes gave the desired results, smooth plant operation was established, and the season's task of bituminous sand separation was commenced. This work proceeded successfully, and the separation of the season's program of 500 tons of bituminous sand was completed on July 22nd.

The redesign, remodelling and operation of the separation plant was under the supervision of S. M. Blair.

*Plant Operations in* 1924

A diagrammatic drawing of the plant built in 1924 is shown in Fig. 12. The treatment box was divided into four compartments Each compartment was of 2 tons capacity, provided with water-tight door and inclined floor and fitted with steam coils. The whole box was mounted on wheels, so any compartment could be discharged into the plant. Bituminous sand was heated in these compartments in contact with silicate of soda solution for some hours, and was then ready for separation. By use of a four compartment treatment box, a supply of treated material was always available.

The treated bituminous sand discharged into a 2 ton steam-heated hopper set over a spiral conveyor which delivered into No. 1 mixing box.

The mixing boxes were of metal, 19½ inches square by 27½ inches deep, with an overflow leading into the corresponding separation boxes. They were provided with paddle agitation.

The separation boxes were of metal, 2 feet wide, 5 feet long and 5 feet deep. They were fitted with steam coils and had a V-shaped bottom with spiral conveyor, leading to a sand sump. A centrifugal pump circulated the hot water from the bottom of the separation box to the mixing box.

The hot, treated bituminous sand in the hot agitated water of the mixing box was dispersed in the form of clean sand and fine drops of bitumen. The dispersed mixture overflowed with the hot water into the separation box where the sand dropped to the bottom in the comparatively still water, while the drops of bitumen floated to the surface forming a thick frothy layer which overflowed through a discharge outlet.

The sand tailings from the first separation box were retreated in a similar manner in the second unit where a further small amount of bitumen was separated.

The plant was driven by a small steam engine, the exhaust from which was ample for all heating required.

This plant was similar to the 1923 plant described in the Fourth Annual Report. The gravity feed of the larger plant eliminated troublesome spiral conveyor lift from the treatment to the mixing box. Later experience proved that the maceration given by this conveyor was an important feature in the successful operation of the earlier plant.

The operation of the 1924 plant showed that the design of the treatment box was poor, and much of the bituminous sand escaped treatment. Nevertheless approximately 100 tons of bituminous sand were put through. The results were poor and compared unfavorably with the previous year's work as shown below.

| | 1924. | | 1923. |
|---|---|---|---|
| *Crude Separated Bitumen*: | Best. | Average. | Average. |
| Water | 10% | 29% | 29% |
| Bitumen | 71% | 42% | 62% |
| Mineral Matter | 11% | 30% | 9% |
| *Sand Tailings*: | | | |
| Bitumen | 2.5% | 4% | 3% |

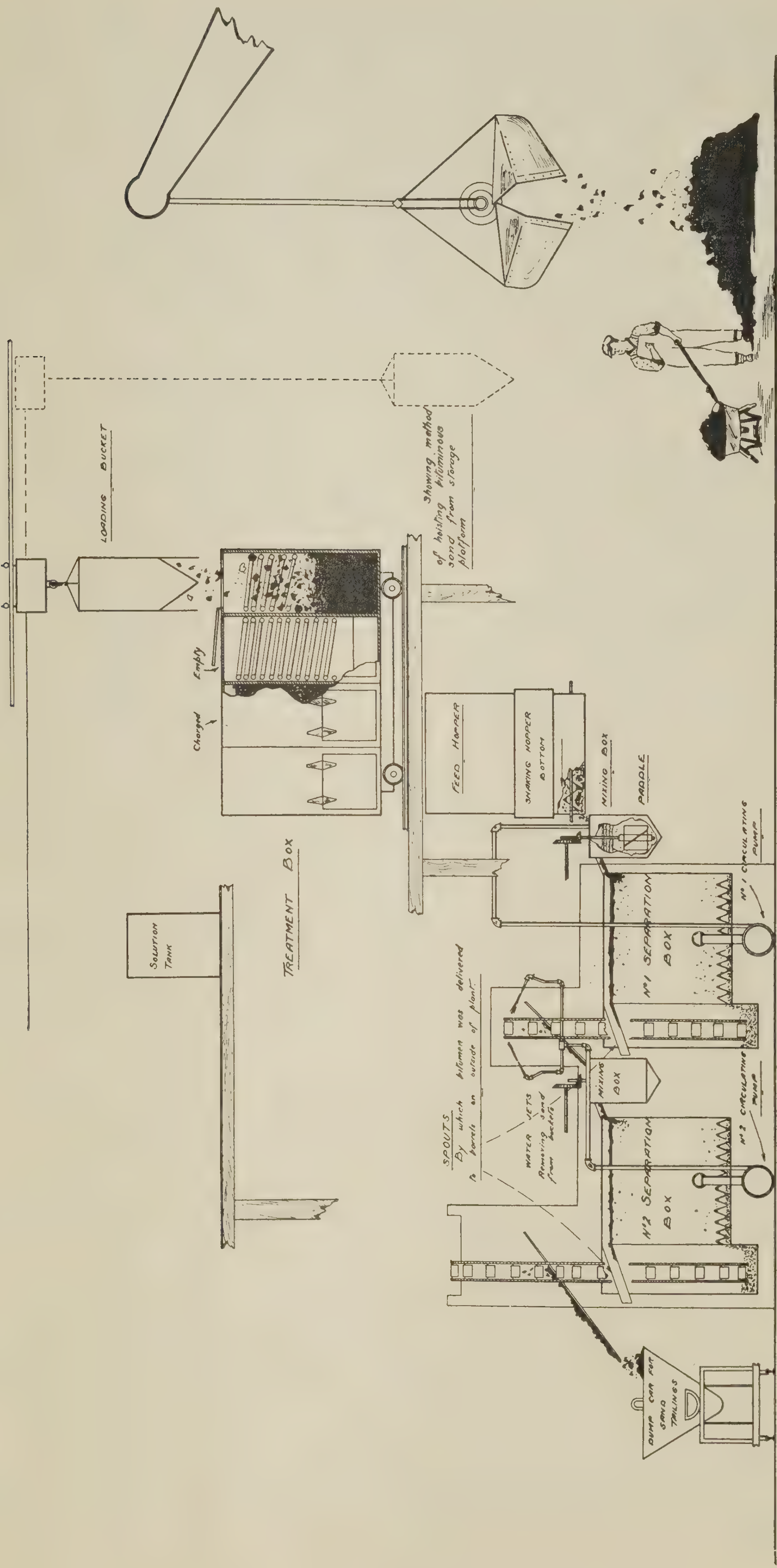


**Figure 12.**—Bituminous Sand Separation Plant in 1924.

The chief difficulty was undoubtedly inability to properly treat the bituminous sand previous to separation. Another difficulty became increasingly evident as operations proceeded. Some shipments of bituminous sand were harder to separate than others, and attempts to separate the final carload of the season failed almost completely. All shipments contained a fair proportion of material coming from the weather face of the exposure mined, but the last carload received consisted almost entirely of weathered material. The experience with it confirmed the growing belief that bituminous sand must be fresh and free from weathering to be readily amenable to the separation process.

### *Laboratory Investigation of Plant Difficulties*

It was obvious that alterations to the plant were necessary. Factors influencing the treatment process were studied during the winter in the laboratory in a small working plant. From 15 to 50 lbs. of bituminous sand were treated each run, and nearly 200 runs were made.

The laboratory apparatus had all the parts of the separation plant with mechanical complication eliminated. The treatment box was of sheet metal, in which were three covered pails. The pails containing bituminous sand were surrounded by water heated to boiling by live steam. The mixing box, agitated by a paddle, delivered into a separation box 24″x24″x16″, with an overflow for separated bitumen. The water level was kept below this overflow by a 2″ pipe leaving the box near the bottom, rising to about the height of the overflow and then running horizontally to a large steel barrel, from which it was pumped into the mixing box. The water in the barrel was heated by live steam. A meat mincer with power drive could be used either for intimately mixing together heated bituminous sand and silicate of soda solution, or for feeding treated bituminous sand into the mixing box. Later a steam jacketed kneading and mixing machine was used for macerating the bituminous sand with the silicate solution.

The bitumen that separated during an experiment floated on the surface and was removed after the run by skimming through the overflow spout. The sand tailings were dug out.

Experiments with this apparatus yielded definite results along the three lines discussed below.

1. *Comparison of fresh and weathered bituminous sand.*—The supply of bituminous sand for these investigations was taken from one of the carload shipments received during 1924. It contained both fresh and weathered material. Fifty pounds of this material, together with the necessary silicate of soda solution, was placed in the treatment box for a definite period of time. The mixture was then put through the mincing machine to break down lumps and aid in the mixing of bituminous sand and solution, and the mixture was then returned to the treatment box for further heating and soaking.

Some of the bituminous sand was then hand sorted and runs made on fresh material and weather material separately. Runs were also made on samples from the last carload received in 1924, which was chiefly weathered material.

Results obtained are shown in Table No. 4. These figures demonstrate the effect of weathering on the quality of both the separated bitumen and the sand tailings.

These experiments showed that weathered material is not amenable to the separation process. Consignments with a high percentage of weathered material will give inferior results.

The subsequent experiments were made on bituminous sand from which the weathered lumps were removed.

2. *Design of mixing box.*—Observation during 1924 seemed to indicate that more violent agitation in the mixing boxes would improve results. To investigate this an old centrifugal pump was attached to the laboratory apparatus to serve as a mixing box. Runs were made with the rotor in operation giving violent agitation and with the rotor idle when the apparatus acted as a simple pipe with the mixture passing through a number of right angle turns.

The results obtained are shown in Table 5. They indicate that violent agitation is not essential to the process.

TABLE IV.

BITUMINOUS SAND SEPARATION EXPERIMENTS ON FRESH AND WEATHERED MATERIAL

(Bituminous sand treated with 20% by weight of 2% Silicate of Soda Solution.)

| Material Treated | Treatment | | Composition of Products | | | | |
|---|---|---|---|---|---|---|---|
| | | | Separated Bitumen | | | | |
| | Macerations | Time of heating, hrs. | Water % | Bitumen % | Mineral matter % | Mineral matter dry basis % | Sand Tailings Bitumen % |
| Mixed fresh and weathered | 1 | 28 | 26.0 | 68.0 | 6.0 | 8.0 | 1.4 |
| Ditto | 1 | 28 | 31.5 | 60.0 | 8.5 | 12.5 | 3.7 |
| Ditto | 1 | 24 | 25.0 | 52.0 | 23.0 | 31.0 | 2.2 |
| Ditto | 1 | 24 | 24.5 | 54.0 | 21.5 | 29.0 | 7.0 |
| Ditto | 1 | 24 | 26.5 | 63.5 | 10.0 | 13.5 | 3.0 |
| Ditto | 1 | 24 | 23.3 | 58.0 | 18.7 | 24.0 | 4.0 |
| Weathered lumps only | 1 | 24 | 20.2 | 44.8 | 35.0 | 44.0 | 8.5 |
| Weathered lumps removed | 1 | 24 | 25.4 | 62.3 | 12.3 | 16.5 | 3.5 |
| Ditto | 3 | 24 | 25.8 | 67.9 | 6.3 | 8.5 | 3.3 |
| Ditto | 3 | 24 | 24.4 | 65.7 | 9.9 | 13.0 | 3.8 |
| Ditto | 3 | 24 | 25.4 | 67.1 | 7.5 | 10.0 | 2.2 |
| Ditto | 3 | 24 | 26.0 | 69.1 | 4.9 | 6.6 | 1.9 |
| Last carload of 1924 | 3 | 60 | 21.0 | 44.8 | 34.2 | 43.0 | 7.4 |
| Ditto | 4 | 60 | 18.6 | 42.4 | 39.0 | 48.0 | 8.7 |
| Ditto | 6 | 60 | 20.0 | 49.9 | 30.1 | 38.0 | 8.6 |

The mixing box, therefore, was simplified to a simple pipe, but to prevent the possibility of the separating sand carrying bitumen down into the tailings, this pipe was arranged to discharge into the separating box below water level.

3. *Treatment process.*—The method of treating bituminous sand to prepare it for separation, used in the plants of 1923 and 1924, and in previous laboratory work, was to place the bituminous sand in a container with enough dilute silicate of soda solution to soak it well, but without excess, and then to heat to a temperature of about 100°C for some hours. Mechanical mixing was not used for two reasons: it was feared that if a preliminary separation took place before proper conditions were established poor separation results would follow, and it was desired to avoid the use of unnecessary power. Moreover, previous experiments were taken to indicate that effective treatment required considerable time. A review of the treatment process was made to find a quicker procedure for large plant operation.

Experiments were carried out using the mincing machine previously mentioned as a macerator and mixer, and also using a steam jacketted mechanical kneading and mixing machine.

The results obtained are shown in Table VI. They indicate that mechanical mixing increases the efficiency of the process and greatly reduces the treatment time required.

### *Plant Operations in* 1925.

The large plant at the Dunvegan Yards was remodelled early in the spring along the lines indicated by the laboratory experiments. In particular the old treatment box was abandoned and a clay mixing machine substituted.

The modified plant is shown in Fig. 13. The bituminous sand was elevated and dumped into a hopper over a set of rolls. These rolls delivered to the mixing machine a stream of bituminous sand free from any sizable lumps. The mixing machine consisted of a trough containing paddles forming a discontinuous worm on a shaft. The trough was banked with steam coils and fitted with perforated pipes for introducing live steam into the mixture. The silicate of soda solution was added with the bituminous sand. Extra water could also be added. The old mixing box with paddle was discarded and a three-inch pipe substituted. The hot, treated bituminous sand entered a funnel on the top of the pipe and was washed down with a stream of water into the separation box, where the bitumen floated to the surface. The sand tailings were re-elevated and fed to No. 2 separation box where the remainder of the bitumen was removed.

Treatment of large quantities of bituminous sand caused the circulating water to become heavily charged with silt and clay. To offset this, a small stream of fresh water was continuously run into the plant and a stream of dirty water thrown away.

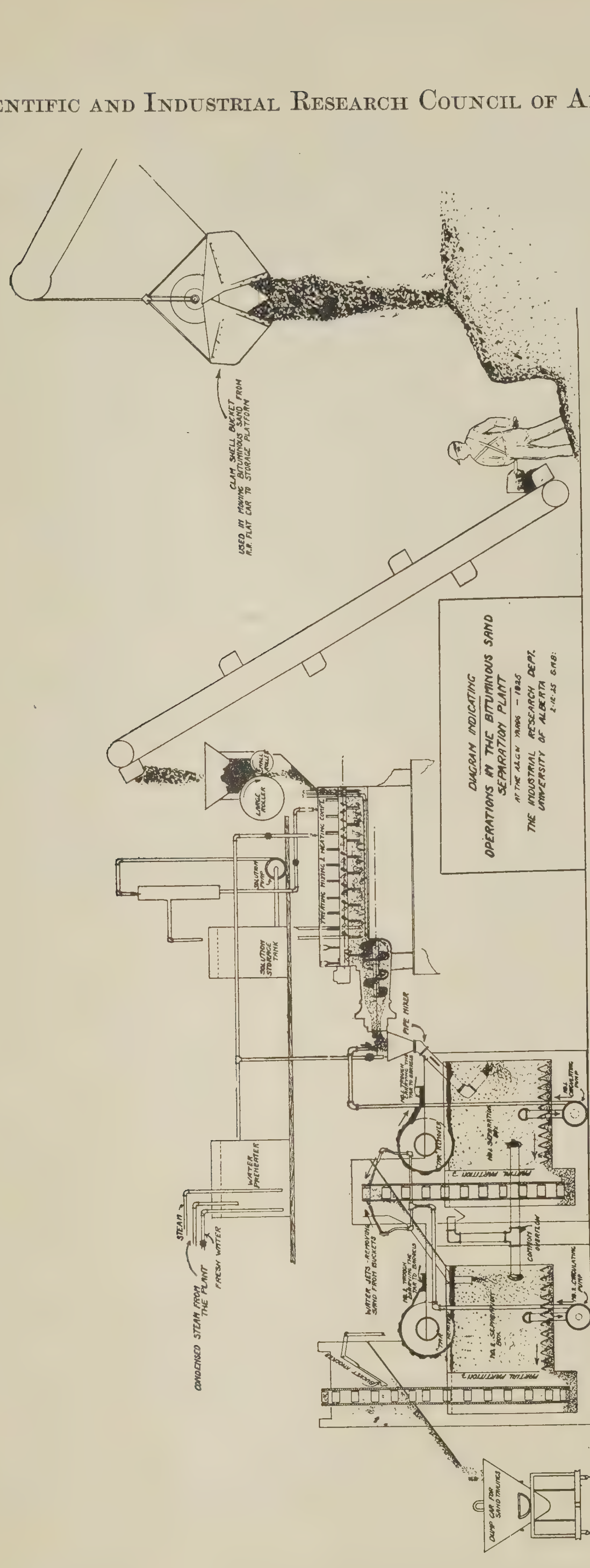


Figure 13.—Bituminous Sand Separation Plant in 1925.

## TABLE V.

BITUMINOUS SAND SEPARATION EXPERIMENTS WITH AND WITHOUT MECHANICAL AGITATION

| Treatment | | Composition of Products | | | | |
|---|---|---|---|---|---|---|
| | | Separated Bitumen | | | | Sand Tailings |
| Time of heating, hours | Agitation | Water % | Bitumen % | Mineral matter % | Mineral matter dry basis % | Bitumen % |
| 24 | Yes | 25.8 | 71.3 | 2.9 | 3.9 | 0.6 |
| 24 | Yes | 30.2 | 67.7 | 2.1 | 3.0 | 0.5 |
| 48 | Yes | 30.0 | 67.6 | 2.4 | 3.4 | 0.7 |
| 24 | No | 26.7 | 71.3 | 2.0 | 2.7 | 0.4 |
| 48 | No | 22.6 | 76.3 | 1.1 | 1.4 | 0.7 |
| 48 | No | 28.0 | 70.3 | 1.7 | 2.4 | 1.5 |

## TABLE VI.

BITUMINOUS SAND SEPARATION EXPERIMENTS. COMPARISON MACERATION AND TIME OF TREATMENT

| Treatment | | Composition of Products | | | | |
|---|---|---|---|---|---|---|
| | | Separated Bitumen | | | | Sand Tailings |
| Maceration | Subsequent heating, hours | Water % | Bitumen % | Mineral matter % | Mineral matter dry basis % | Bitumen % |
| Minced | 4 | 35.6 | 54.1 | 10.3 | 16 | 3.7 |
| " | 24 | 28.0 | 76.9 | 5.1 | 6 | 3.2 |
| " | 48 | 27.0 | 66.4 | 6.6 | 9 | 2.9 |
| Minced and kneaded | 6 | 27.6 | 70.2 | 2.2 | 3 | 0.5 |
| Ditto | 24 | 25.8 | 71.3 | 2.9 | 3.9 | 0.6 |
| Ditto | 48 | 22.6 | 76.3 | 1.1 | 1.4 | 0.7 |
| Kneaded 30 minutes | | 24.3 | 73.4 | 2.3 | 3.0 | 1.3 |
| Ditto | | 27.4 | 70.2 | 2.4 | 3.3 | 0.7 |
| Ditto | | 21.4 | 76.8 | 1.8 | 2.3 | 0.9 |
| Ditto | | 19.7 | 78.2 | 2.1 | 2.6 | 0.6 |
| Ditto | | 24.0 | 73.2 | 2.8 | 3.7 | 0.8 |

In brief, the treatment box was discarded and the quick acting mixing machine substituted. A simple pipe arrangement was substituted for each of the former mixing boxes. The McMurray Asphaltum & Oil Co. co-operated by supplying bituminous sand as free as practicable from weathered material.

The plant was put in operation towards the end of June, and the estimated capacity of one ton per hour easily maintained Forcing the capacity above one and one-half tons per hour reduced the quality of the product.

The season's programme of separating 500 tons of bituminous sand was successfully concluded by the third week of July.

Representative samples of the crude separated bitumen and of the sand tailings were taken daily. The average analysis of 75 samples was as follows:

| | |
|---|---|
| *Crude Separated Bitumen:* | |
| Water | 28% |
| Bitumen | 65% |
| Mineral Matter | 7% |
| *Sand Tailings:* | |
| Bitumen | 2% |

This shows a great improvement over the 1924 operations. Much of the bitumen remaining in the tailings was in the form of small lumps of weathered bituminous sand, and the sand content of the separated bitumen was doubtless higher than it would have been if no weathered material had been present. The sand tailings in the main were so free from bitumen that they dried out to a loose sand that blew off the tailings dump. This action left pea sized lumps of weathered bituminous sand visible on the surface.

The bitumen produced by the separation process contains a high percentage of water, and the problem of its elimination has yet to be studied. Recognized methods employed with other wet bitumens may prove effective.

## Earth Road Treatments

In order to study the value of the separated bitumen, and crude mineral oil from the Wainwright district, for waterproofing and stabilizing dirt roads, one mile of earth road on the St. Albert Trail near Edmonton was treated experimentally during the 1925 season.

Laboratory work, as well as a small road experiment on the Fort Trail during 1923, had indicated that admixture of the separated bitument would prevent the soils of Alberta roads from softening and turning to mud in wet weather. The success of these experiments warranted more extensive investigation. Furthermore, since a heavy crude oil is now being produced at Wainwright, it was considered advisable to also study the use of this oil on earth roads. Consequently the mile of experimental road was divided into two main parts, one of which was treated with separated bitumen, and the other with Wainwright oil.

The road experiment was made on the first mile of the St. Albert Trail beyond the north limit of the City of Edmonton. The test strip commences approximately half a mile past the city pavement, which ends at the railway station at the Dunvegan Yards. The site chosen was close to the bituminous sand separation plant at the Dunvegan Yards. It was on a main highway—probably the heaviest travelled road entering Edmonton. And it passed through a heavy clay soil condition which presented about the maximum of difficulty in securing a satisfactory road surface. There was an element of disadvantage in thus attacking the most difficult conditions at this early stage of road experiments.

The Department of Public Works graded the mile of road according to the standard specifications of the province for main highway construction. The grade was made 18 feet wide from shoulder

to shoulder. The surfacing work followed immediately after the new grading, although it would have been better if a year had elapsed between the grading work and the surfacing to allow the road bed to thoroughly settle and consolidate.

### *Bituminous Materials Used*

The British Petroleums, Ltd., at Wainwright, gave one hundred barrels of Wainwright crude oil for the work. One hundred additional barrels were purchased.

These consignments of crude oil contained a considerable proportion of water in emulsified form, and a certain amount of clay in suspension. It is a heavy crude oil of asphaltic base, and pours as readily at ordinary temperatures as heavy machine oil.

The crude separated bitumen from the separation plant contained about thirty per cent. by weight of emulsified water, and seven per cent. of clay and sand. The bitumen itself is a very heavy, viscous, sticky material, and is, in fact, a very soft form of asphalt. It is too soft at ordinary temperatures for the penetration tests used with pavement asphalts, but too viscous to pour except in the most sluggish fashion. Heated to 100°C it is about as fluid as the Wainwright crude oil is at ordinary temperatures.

### *Procedure*

In general, the process consisted of loosening the surface, introducing the oil or bitumen, mixing, packing down the oil-soil mixture, and then giving a surface dressing of oil or bitumen covered with sand or cinders.

The top soil of the road was loosened by ordinary farm disc harrows, but where the clay surface was dry and hard, a plow was first used to break it up. The disc-harrows ground the hard clay slowly, but finally, to fairly fine dirt. The discs also served to mix the oil or bitumen into the loose soil.

The oil or bitumen was heated in a kettle similar to the type used for heating asphalt for pavement repair work, and was spread on the road in an even layer by means of a simple oil distributor. Each application consisted of about one-quarter gallon per square yard of surface.

A road tamper was used to compact the surface treated with Wainwright oil. This tamper weighed about 4,500 lbs., and consisted of seven iron discs mounted on an axle. The discs were three inches wide on their faces and were spaced about eight inches apart. The soil treated with bitumen stuck to the tamper so that it could not be used on this part of the road. A grader and drag were used on both sections.

Traffic continued on the road during the treatment. It helped to mix the earth and oil or bitumen together and, with the aid of the drag, did the final packing of the treated soil.

The north two thousand feet of road were treated with the Wainwright oil. This stretch has a gentle slope, with the southern end in low-lying and very clayey land. The soil appears to become progressively less clayey up the grade. The south thirty-five hundred feet of road were treated with the bitumen. This stretch is on a flat of heavy clay soil, but dips to the north through the low lying land where the soil is particularly heavy.

Each stretch of road was divided into five hundred foot sections. It was planned to vary the depth of soil treated in a regular succession of increasing depths, but practical difficulties interfered. It was found impossible to loosen an exact depth of hard clay over a five hundred foot section. Modifications in the work were made from time to time in the light of experience. The range of variation of treatment is shown in Table VII.

Table VII.

EARTH ROAD TREATMENT—SUMMARY BY SECTIONS

| No. of Sec. | Soil Treatment | | | Surface Treatment | | |
|---|---|---|---|---|---|---|
| | Depth of soil treated inches | Material used | Quantity of material gal. sq. yd. | Type of material used | Quantity of material gal. sq. yd. | Final surface covering |
| 1 | 1 to 2 | Crude oil | 1.3 | Crude oil | 0.2<br>0.3 | Sand tailings<br>Concrete sand |
| 2 | ½ | " | 1.1 | " | 0.2<br>0.2 | Sand tailings<br>Concrete sand |
| 3 | 2 to 3 | " | 2.0 | " | 0.2<br>0.3 | Sand tailings<br>*Concrete sand |
| 4 | 1 to 1½ | " | 1.2 | " | 0.6 | Concrete sand |
| 5 | 3 | Crude Bit. | 2.7 | Crude Bit. | 0.5 | Cinders |
| 6 | 2 to 2½ | " | 2.3 | " | 0.5 | Cinders |
| 7 | 1 to 1½ | " | 2.0 | " | 0.45 | Cinders |
| 8 | 1 to 1½ | " | 2.0 | " | 0.45 | Cinders |
| 9 | 1 to 1½ | " | 2.0 | " | 0.45 | Cinders |
| 10 | 1½ | " | 2.0 | " | 0.7<br>0.6 | Cinders<br>Cinders |
| 11 | 1½ | 50/50 mix. crude oil & bitumen | 1.2 | " | 0.7<br>0.6 | Cinders<br>Cinders |

Note: Sections are numbered from the northern end toward the city. Each section is 500 feet in length. Their locations are marked by signs along the roadway.
The soil conditions throughout the mile of road was heavy clay. Sections 1 to 4 are somewhat less clayey and sections 5 and 6 somewhat more clayey than the other sections.
*Two types of surface dressing were in some cases used on different portions of the same section.

## *Detailed Description of Sections*

Section No. 1—

Depth of soil loosened: 1″ to 2″.

Oil mixed in: 28 barrels of Wainwright crude oil, or approximately 1.3 gals. per sq. yard.

Surface applications: (1) 4 barrels of crude oil (0.2 gals. per sq. yd.), dressed with sand tailings from the separation plant. (2) 6 barrels of crude oil (0.3 gals. per sq. yd.), dressed with concrete sand.

The original plan was to apply 20 barrels of oil to the surface of this section without loosening the soil at all, as much road oiling is done elsewhere in this way. However, the oil did not penetrate the clay soil and traffic stripped it off. Consequently the section was later disced up and treated as indicated.

SECTION NO. 2—

Depth of soil treated: Probably not more than ½″.
Oil mixed in: 25 barrels of crude Wainwright oil (approx. 1.1 gals. per sq. yd.)
Surface applications: (1) 5 barrels crude oil (0.2 gals. per sq. yd.), dressed with sand tailings from the separation plant. (2) 5 barrels crude oil (0.2 gals. per sq. yd.), dressed with concrete sand.

The soil was loosened by discing to a depth of about one inch. The loose soil was pushed to the sides of the road with the grader and oil was spread on the centre. The soil was then put to the centre, and the oil spread on the sides, and so on. After the first grading, there did not seem to be more than half the original quantity of loose dirt available for replacement. The result was that the 25 barrels of oil were mixed into, or buried under, a very thin covering of loose dirt over the hard clay of the roadbed. Thus, in fact, this section got the surface oiling planned for section No. 1. Mixing the oil into the soil by the grader was not tried again.

SECTION NO. 3—

Depth of soil loosened: 2″ to 3″.
Oil mixed in: 44 barrels crude Wainwright oil (2.0 gals. per sq. yd.).
Surface applications: (1) 5 barrels crude oil (0.2 gals. per sq. yd.), dressed with sand tailings from the separation plant. (2) 6 barrels crude oil (0.3 gals. per sq. yd.), dressed with concrete sand.

In attempting to get at least two inches of soil loosened everywhere on this section, more than two inches were disced up in many parts. The treated soil did not pack down satisfactorily, and patches persisted in breaking out into chuck holes.

SECTION NO. 4—

Depth of soil loosened: 1″ to 1½″.
Oil mixed in: 27 barrels crude Wainwright oil (1.2 gals. per sq. yd.).
Surface applications: 13 barrels crude oil (0.6 gals. per sq. yd.), covered with a heavier dressing of concrete sand than was given other sections.

The original plan was to treat this section to a greater depth than No. 3. However, the supply of oil was not sufficient for the necessary treatment to a greater depth, and the poor results obtained with section No. 3 discouraged deeper treatment.

SECTION NO. 5—

Depth of soil loosened: 3″.
Bitumen mixed in: 59 barrels of crude bitumen from the bituminous sand separation plant (2.7 gals. per sq. yd.).
Surface application: 12 barrels crude bitumen (0.5 gals. per sq. yd.), dressed with cinders.

This section was in the lowest part of the mile of road and in the heaviest clay. The attempt was made to give it a deep treatment with bitumen, but this aim was only partially achieved. While no difficulty was experienced in mixing the Wainwright crude oil uniformly with the loosened soil, it was found impossible to do so

with the crude bitumen. The bitumen cooled and stiffened soon after being spread. The action of the disc harrows was merely to cut and work dirt into the bitumen, and a uniform distribution was not attained even after prolonged discing. Masses of bitumen rich mixtures came to the surface leaving leaner mixtures below. Unlike section No. 3 this section packed well. It went down very quickly under traffic and became as hard as the original packed clay road.

SECTION NO. 6—

Depth of soil loosened: 2″ to 2½″.
Bitumen mixed in: 52 barrels of crude bitumen (2.3 gals. per sq. yd.).
Surface application: 12 barrels crude bitumen (0.5 gals. per sq. yd.), dressed with cinders.

The notes on Section No. 5 also apply to this section.

SECTIONS NOS. 7, 8 AND 9—

Depth of soil loosened: 1″ to 1½″.
Bitumen mixed in: 45 barrels of crude bitumen (2.0 gals. per sq. yd.).
Surface application: 10 barrels crude bitumen (0.45 gals. per sq. yd.), dressed with cinders.

These three sections were treated together as one section. Experience with Sections Nos. 5 and 6 showed that even with a considrable depth of loosened soil, the bitumen concentrated in the surface. In these later sections only a shallow depth of soil was provided so that none of the bitumen could get down deeper where it would be in too small quantity to do any good. The scheme was fairly successful, but it was found difficult to get an even distribution of the richly bituminized loose dirt over the road surface, and the dirt tended to stick together and to separate from the hard clay below when graded.

SECTION NO. 10—

Depth of soil loosened: 1½″.
Bitumen mixed in: 45 barrels crude bitumen (2.0 gals. per sq. yd.).
Surface application: (1) 15 barrels crude bitumen (0.7 gals. per sq. yd.), dressed with cinders. (2) 14 barrels crude bitumen (0.6 gals. per sq. yd.), dressed with cinders.

The soil on this section was loosened somewhat deeper than Nos. 7, 8 and 9, so as to avoid, if possible, some of the difficulty of final distribution of the soil-bitumen mixture.

Whereas the earlier sections were completed in fine weather with not more than an occasional shower, during the treatment of this section and No. 11, there was heavy and prolonged rain. The rain came after the bitumen had been mixed into the loose soil, but before a surface application of bitumen and cinders had been made. The section softened and traffic cut it considerably. It was graded back into shape, but before it could dry properly, a dressing of bitumen and cinders was placed on it. It would have been preferable to wait until the section was dry before surfacing, but the weather was threatening and, in fact, rain commenced to fall heavily. The traffic again cut the central part of the section, but not badly. It was again dragged, and after one day of fine drying weather was given a second surfacing of bitumen and cinders. Wet weather followed, but the section held well.

SECTION No. 11—

Depth of earth loosened: 1½″.

Bitumen mixed in: 27 barrels (1.2 gals. per sq. yd.) of a mixture approximately half and half crude bitumen and crude Wainwright oil.

Surface application: (1) 5 barrels crude bitumen (0.7 gals. per sq. yd.), dressed with cinders. (2) 13 barrels crude bitumen (0.6 gals. per sq. yd.), dressed with cinders.

A few barrels of crude Wainwright oil remaining were used mixed with crude bitumen. The mixture heated and sprayed readily and mixed uniformly and without difficulty into the loose soil. A strip of surface dressing of bitumen and cinders was applied along each side of the road before the heavy rain came. The traffic cut the central, and as yet uncarpetted, part of the section. This portion was dragged into shape and given its bitumen and cinder dressing before it had properly dried and hardened. After one day of drying weather a second dressing of bitumen and cinders was made.

*General Observations*

The number of barrels of oil or bitumen applied to any section was determined from the number of tanks of material sprayed on the road.

The crude Wainwright oil heats quickly, sprays readily and is easy to handle, but owing to its water content, it froths badly when approaching 100°C. The hot crude oil was readily strained while running into the oil distributor and the strained oil sprayed without difficulty.

Cold, stiff bitumen in contact with the bottom of the heating kettle tended to overheat while the bulk of the mass remained cold, and much stirring, and careful firing, was required. Straining of the hot bitumen was a somewhat slow affair, and difficulty was experienced in keeping the nozzles of the oil distributor clear and functioning properly.

Crude Wainwright oil mixed readily and uniformly into the loose dirt with very little mechanical mixing. The presence of the oil in the soil seemed to make it "short", as the oiled clay soil appeared to have lost much of the property of compacting and hardening characteristic of the untreated clay soil. This was particularly apparent in Section No. 3, where the greatest depth of loosened soil was oiled. Patches of this section persisted in breaking up into chuck-holes of powdery oiled soil. Little can be accomplished by dragging a hard, clay soil road, in dry weather, but Sections Nos. 1 to 4 could be dragged at any time. This experience with the Wainwright oil is in keeping with experience in earth road oiling elsewhere. Most oiling with oils fluid at ordinary temperatures, is done on thoroughly compacted earth roads by spraying the oil onto the surface and allowing it to soak into the hard, bonded soil. The Wainwright crude oil is too thin to act as a binder, and it weakens the natural soil bond.

The crude bitumen from the bituminous sands behaves quite differently when mixed into the soil. It has no tendency to spread through the loose soil, but has to be forcibly worked into it. The

soil-bitumen mixture packs hard, as the bitumen has sufficient body to act as a very effective binder. Sections Nos. 5 and 6 packed so hard that a grader had little more effect on them than it would have had on a pavement.

The oil-soil and bitumen-soil mixtures have each advantages and disadvantages. The oiled soil, because of its loose bond, can be put out of shape by traffic, but can be easily put back into shape by dragging. The bitumen-soil mixture surface is not easily destroyed under traffic, but if damaged requires to be patched.

The experimental road work was completed on August 13th. Heavy rains set in almost immediately, and wet weather was frequent during the balance of August and all September, and in the late Autumn several falls of snow occurred which melted away slowly. Altogether, the road has been subjected to somewhat severe conditions. The 7 sections treated with bitumen stood the test well. When last seen, early in December, they were firm and smooth. Wet snow was lying on the road surface, but the road was carrying the traffic satisfactorily. Sections Nos. 10 and 11 showed the most marking, which is not surprising, since they were finished in a wet and soft state. Apparently no further damage was done once the road surface had dried after completion.

The oiled sections Nos. 1 to 4 had not fared so well. Sections Nos. 3 and 4 have cut and rutted very badly. These are the most clayey of the oiled sections. Sections Nos. 1 and 2 have stood much better, but the surface softens and marks up very decidedly during wet weather. When last visited in 1925 these sections were soft on the surface, but not sticky as was the untreated clay road beyond the experiment.

It has been mentioned that the oiled sections Nos. 4, 3, 2 and 1 are on a gentle slope, and that the soil gets less clayey as one passes over the sections in the order mentioned. It appears probable that the crude Wainwright oil is more effective in protecting the less clayey soil of Sections Nos. 1 and 2 against water than it is with the more clayey sections, Nos. 3 and 4. Possibly soil types less clayey than that of the soil encountered in the experimental road would be effectively stabilized by the Wainwright oil. The soil experimented with contains more clay than is usual in the soils of the province.

### *Treatment Costs*

It will be readily understood that such experimental work is inherently more expensive than work done on a routine basis, and the unit cost for such a short stretch of road is greater than the unit cost for extensive work. The actual expenditures suggest that the cost of large scale operations along these lines would be comparatively low, probably between $1,500 and $3,000 per mile.

# FOREST PRODUCTS OF ALBERTA: MINE TIMBER

By R. S. L. Wilson

*Professor of Civil Engineering, University of Alberta*

The series of tests on mine booms and props of lodge pole pine mentioned and described in previous annual reports has been continued during 1925. (See 1923 Annual Report, pages 74 to 75, and 1924 Annual Report, page 66.)

Up to the end of 1925, 1,080 test pieces were placed underground, 540 of these were green and 540 seasoned (14 months). Half of each, or 540 altogether were peeled and 540 unpeeled. One-third of all the pieces, or 360, were placed in return air, 360 in dead air, and 360 in intake air. All experiments are classified respecting period in service into: 360 first period, 360 second period, and 360 third period; and again classified into 360 booms and 720 props.

Ten timber sets of 10 booms and 20 props divide into one batch of booms and one batch of props.

It can be seen from the above that there are 72 batches of test pieces and that each experiment includes equal portions of green and seasoned, peeled and unpeeled, etc., etc. In addition there are several batches tested structurally to determine the characteristics of the timber before placing it underground.

The series of batches of green timber placed during December 1923-January 1924 is known as Series I. The series of batches of seasoned (14 months) timber placed during February, 1925, is known as Series II.

The mine locations in "Return Air", "Dead Air", and "Intake Air", are known as Locations I, II and III respectively.

Tests of all the "Green" "First Period" batches (12) and the "Green" "Location II" "Second Period" batches (4) are completed. Additional batches (8) of "Green", "Seasoned" (9 months) "Unpeeled", and "Seasoned" (14 months), have also been tested structurally.

Inspections of the timber at the mine were made during 1925 in the months of January, May and November. In January, the timber which had been stored at the surface for seasoning was found in apparently sound condition and free of fungus. Two batches of peeled and two batches of unpeeled were taken to the University for structural tests, and the remainder was placed underground in the same locations as the batches of Series I.

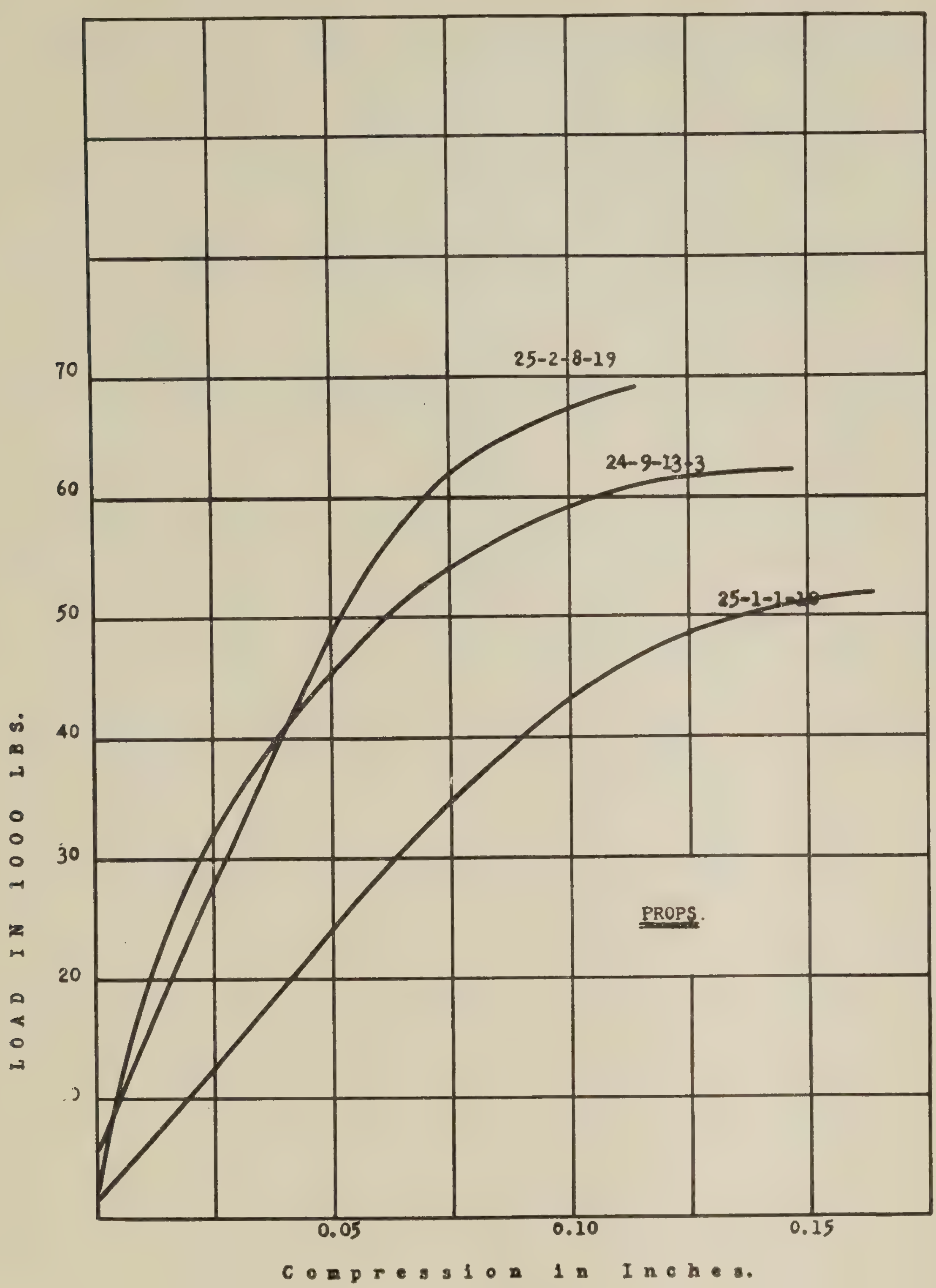


**Figure 14.**—Typical load—compression curves for props.

In May and November the following conditions were noted underground: At "Intake Air", all timber was found to be apparently thoroughly sound. At "Return Air", the environment of the timber was as found in previous inspections April and July, 1924 (see previous annual report), with apparent deterioration in the condition of the timber of Series I—in November an occasional broken boom was found; Series II appeared to be sound in May, but in November the bark was infected, although the peeled were barely touched with fungus. At "Dead Air" in May there was no apparent change since July, 1924, when all the timber of Series I showed fungus; in November the timber of Series II was all sound but touched with fungus.

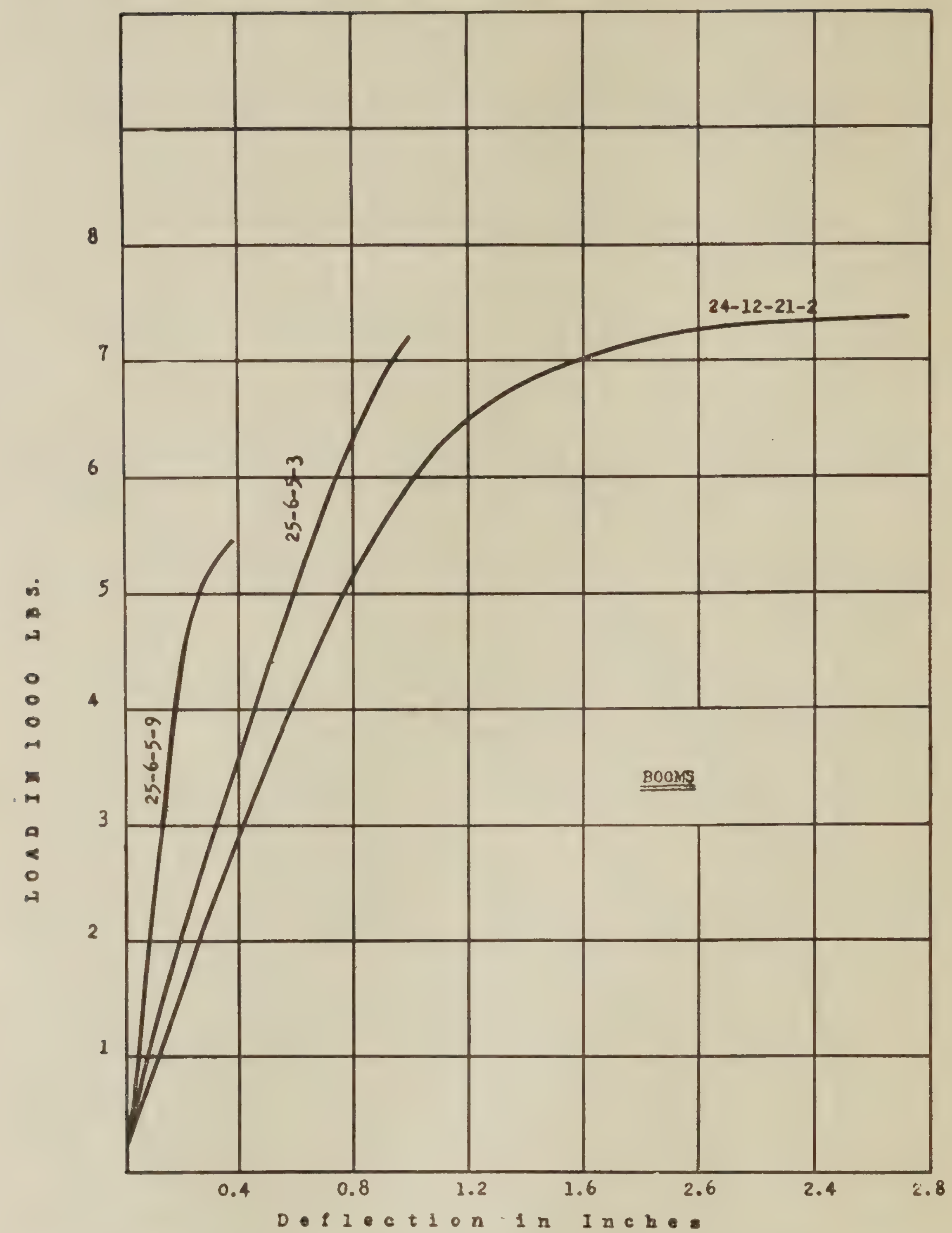


**Figure 15.**—Typical load—deflection curves for booms.

Results of structural tests on a few typical props and booms are described below and shown graphically in Figures 14 and 15.

Prop—Green—Unpeeled—not placed in service—Diam. 4.7 inches—age 58 years—Moisture content 67%.
Column test, 25/1/1/10; Maximum load, 51,800 lbs. Corresponding shortening per 50-inch length, 0.17 inches.
NOTE: Moisture content is given on basis of dry weight.

Prop—Seasoned 14 months—Unpeeled—not placed in service—Diam. 6.2 inches—age 56 years—Moisture content, 59%.
Column Test, 25/2/8/19: Maximum load, 69,000 lbs. Corresponding shortening per 50-inch length, 0.12 inches.

Prop—Green—Peeled—Dead Air—9 months—Diam. 5.5 inches—age 52 years—Moisture content, 73%.
Column Test, 24/9/13/3: Maximum load, 62,000 lbs. Corresponding shortening per 50-inch length, 0.15 inches.

Boom—Green—Unpeeled—not placed in service—Diam. 5.7 inches—age 60 years—Moisture content, 65%.
Bending Test, 24/12/31/2: Maximum load, 7,400 lbs. Corresponding deflection (90″ span), 2.72 inches.

Boom—Green—Peeled—Return Air—16 months—Diam. 6.1 inches—age 62 years—Moisture content, 25%.
Bending Test, 25/6/5/3: Maximum load, 7,300 lbs. Corresponding deflection (90″ span), 1.00 inches.

Boom—Green—Unpeeled—Return Air—16 months—Diam. 6.6 inches—age 57 years—Moisture content, 51%.
Bending Test, 25/6/5/9: Maximum load, 5,500 lbs. Corresponding deflection (90″ span), 0.38 inches.

In 1926 observations will be commenced to determine the value of various seasoning periods for peeled timbers, and some studies will be made of chemical treatments.

Acknowledgment of continued courtesies from Messrs. J. C. and A. C. Dunn and their associates of the Great West Coal Company, Limited, is gratefully made.

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